

U.S. DEPARTMENT OF INTERIOR

GEOLOGICAL SURVEY

Descriptions and correlations of coal bed facies:
Lower Freeport(?) coal bed, west-central Pa.

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Open-File Report 85-393

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Introduction

In July 1984, the United States Geological Survey (USGS) entered into a cooperative research effort with the Pennsylvania Electric Company (PENELEC) and the New York State Electric and Gas Corporation (NYSEG) to continue research that the USGS began in previous years in cooperation with the Environmental Protection Agency. The primary objective of this project is to determine and interpret the compositional and geologic parameters that can be related to quality variations of the Lower Freeport(?) coal bed, west-central Pennsylvania (fig. 1). This project complements a larger study being conducted by the Environmental Protection Agency, PENELEC, and NYSEG. The larger study is developing and validating new engineering models to optimize the planning and execution of SO₂ compliance strategies which involve mining, blending, and preparation of coal for electric power generation. Other aspects of the study include: washability analysis of samples obtained from coring, stopped-belt run-of-mine sampling, and channeling; chemical and petrographic characterization of selected samples; and the quantification of X-ray radiographic descriptions for use as a coal bed quality evaluation tool.

Descriptions of sample locations

A total of 37 field descriptions for 11 separate sample sets were made during 1982, 1983, and 1984 (table 1). Initially, channel samples for washability characterization were obtained from each active mining section in the Lucerne #9 mine. In 1983, PENELEC and NYSEG cored through two projected mining areas and then during the advance of mining, obtained a set of channel and stopped-belt run-of-mine (ROM) samples for washability testing. For each location in the mine, channel samples were obtained around both the 30'x30' mined block and the core hole. In 1984, six additional core holes were drilled in projected mining sections following which a minimum of five channel samples and one stopped-belt ROM sample, which represented total section production, were obtained in a manner similar to that of the 1983 sampling. Core from eight drill holes (fig. 2) in the Lower Freeport(?) coal bed was recovered and packaged immediately following extraction from the core barrel. At each mined block, descriptions of the channel sampled facies were made. These descriptions are presented in this report.

Channel sampled faces were described megascopically using criteria similar to that used in describing the Upper Freeport coal bed (Cecil and others, 1981). Descriptive criteria included fracture or breakage type, average bright and dull band widths, minerals along cleats and layers, and fusain layers. Coal bed facies were also delineated by using these criteria. Section sampling layouts and descriptions are presented in figures 4-11; symbols used in figures 4-11 are explained in figure 3. Three other descriptions of channel samples that were obtained in 1982 are shown in figures 12-14.

X-ray radiography

X-ray radiographs were prepared for core numbers 2584 and 2585 (fig. 15) using point-source radiation. Features in these radiographs correlate well with in-mine descriptions made adjacent to the core hole. The primary level of description involves identification of coal bed facies. Facies are mappable units within the bed; although they may change laterally in thickness, they commonly have less areal variation in quality than the whole bed thickness

(Cecil and others, 1981). Each coal bed is composed of one and commonly more facies. Facies are, compositionally, sub-units of the coal bed that are megascopically identifiable and mappable (or have lateral continuity that can be delineated). Areal, facies do not have a consistent composition, however, their compositional and thickness variability is usually less than that of the complete bed. Facies are more readily apparent in the radiographs than they are underground primarily because of conditions under which the descriptions are made. Water on the mined face, dust, and limited lighting all affect the quality of the in-mine description.

Correlation of coal bed facies

The degree of banding is the most obvious difference among facies. Other differences include the amount of fusain and minerals such as pyrite and calcite. A correlation of compiled descriptions is shown in a fence diagram in figure 16. Several observations can be made from this figure: (1) two major interruptions in peat accumulation resulted in the deposition of clay-rich partings probably as a result of flooding; (2) the source of the flood waters was from the south-southeast based on the thickening and decrease of organic content of the clay-rich layers; (3) thick clay-shale layers pinch out and correlate with durain layers (compare figs. 7b-d and 4b-f); and (4) a bright upper facies of the bed (woody paleo-peat) can be found in the northern part of the mine and above the main parting in the southern part of the mine.

There are some similarities between the indicated depositional histories of the Lower(?) and Upper Freeport coal beds as shown in the fence diagram of the Upper Freeport bed (Cecil and others, 1981). Both peat bodies probably began as topogeneous accumulations of peat (filling in low-lying areas). During early stages of peat formation, most areas of the peat swamp were at or below adjacent stream levels. Flooding caused extensive inundation and detrital influx across both swamps, resulting in deposition of a clay-rich parting or mineral-rich durain layer. In the Lower Freeport(?) paleo-swamp, a second major detrital influx was probably restricted to the marginal areas of the swamp because the interior part had changed to a more domed accumulation which was also more acidic, similar to modern ombrogenous (domed) peats. The greater preservation of wood fragments in this acidic, slightly domed environment resulted in a brighter banded coal than in lower facies.

Summary

The initial sampling phase of the cooperative research agreement between the U. S. Geological Survey and PENELEC and NYSEG resulted in a set of megascopic descriptions from which preliminary correlations of coal bed facies could be made and related to depositional factors. These descriptions coupled with related physical, petrographic, and chemical data should make it possible to interpret the geologic factors that relate to the variability of both coal bed quality and cleanability of the Lower Freeport(?) coal bed.

Acknowledgments

The following were especially cooperative to the completion of this phase of the study and to whom we extend our appreciation:

Personnel of Pennsylvania Electric Company, in particular, Francis Martino, Ray McGraw, Susan Latimer, and James Tice;

Personnel of Rochester and Pittsburgh Coal Company, in particular, William Bragonier, Joe Wilcox, Dennis Shay, and Steve Harvan;

Employees of the Lucerne #9 Mine, Helvetia Coal Company, in particular, Mike Gatski, Sam Zack, Mark Lablant, Frank Petro, and Bruce Springer.

Reference cited

Cecil, C.B., Stanton, R.W., and Dulong, F.T., 1981, Geology of contaminants in coal: Phase I report of investigations: U. S. Geological Survey Open-file Report 81-953A, 92 p.

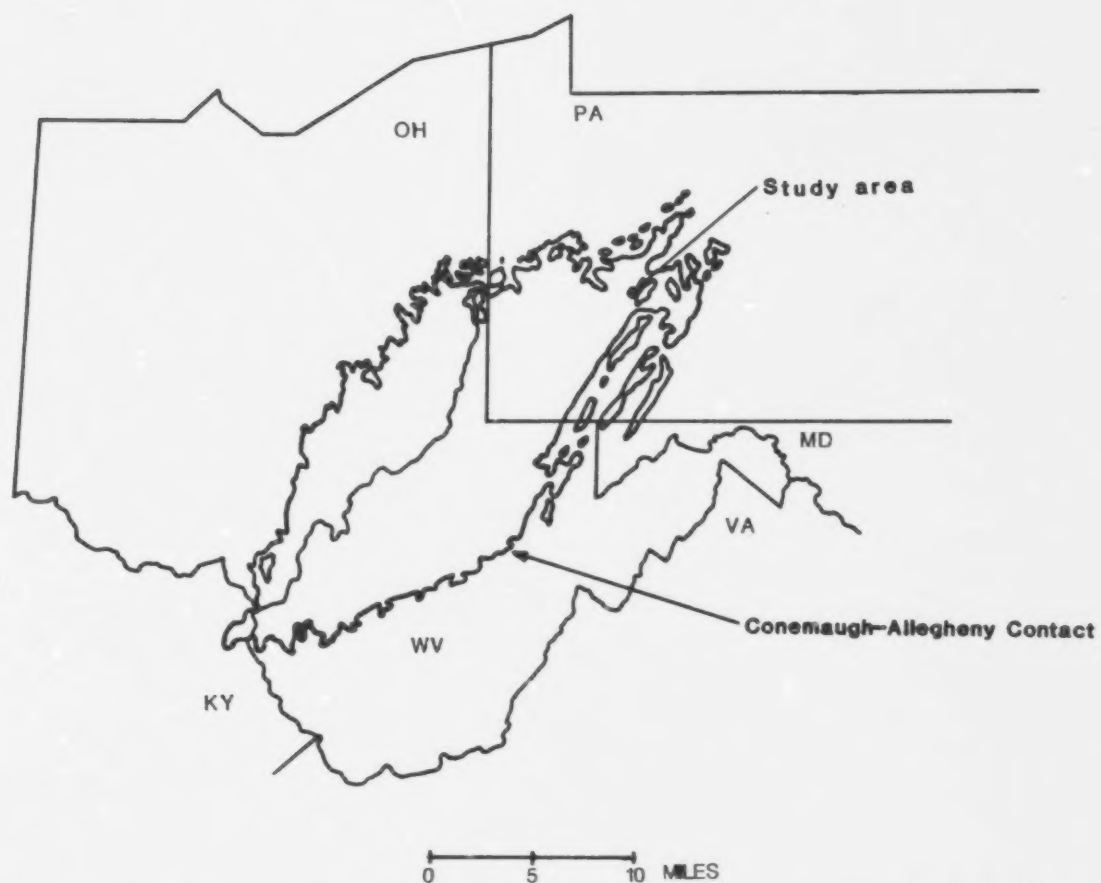


Figure 1. Index map of the study area and Conemaugh-Allegheny contact.



Figure 2. Sample locations in the Lucerne #9 mine, west-central Pennsylvania.

LEGEND

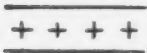
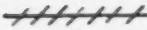
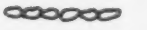
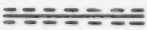
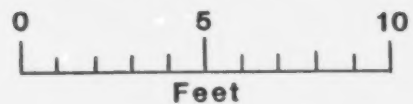
	Canneloid
	Durain and Bone Coal
	Vitrain Band
	Fusain
	Fusain, Massive
	Pyrite
	Shale
	Clay
	Gradational contact

Figure 3. Legend for channel descriptions.

3 SOUTH, 1983

⊕ DH 2584

■ Channel sample



■ 6-3 S

1-3 S

■ 8-3 S

7-3 S

3-3 S

⊕ 4-3 S

5-3 S

Figure 4a. Location of channel descriptions in 3 South and core #2584, 1983 sampling.

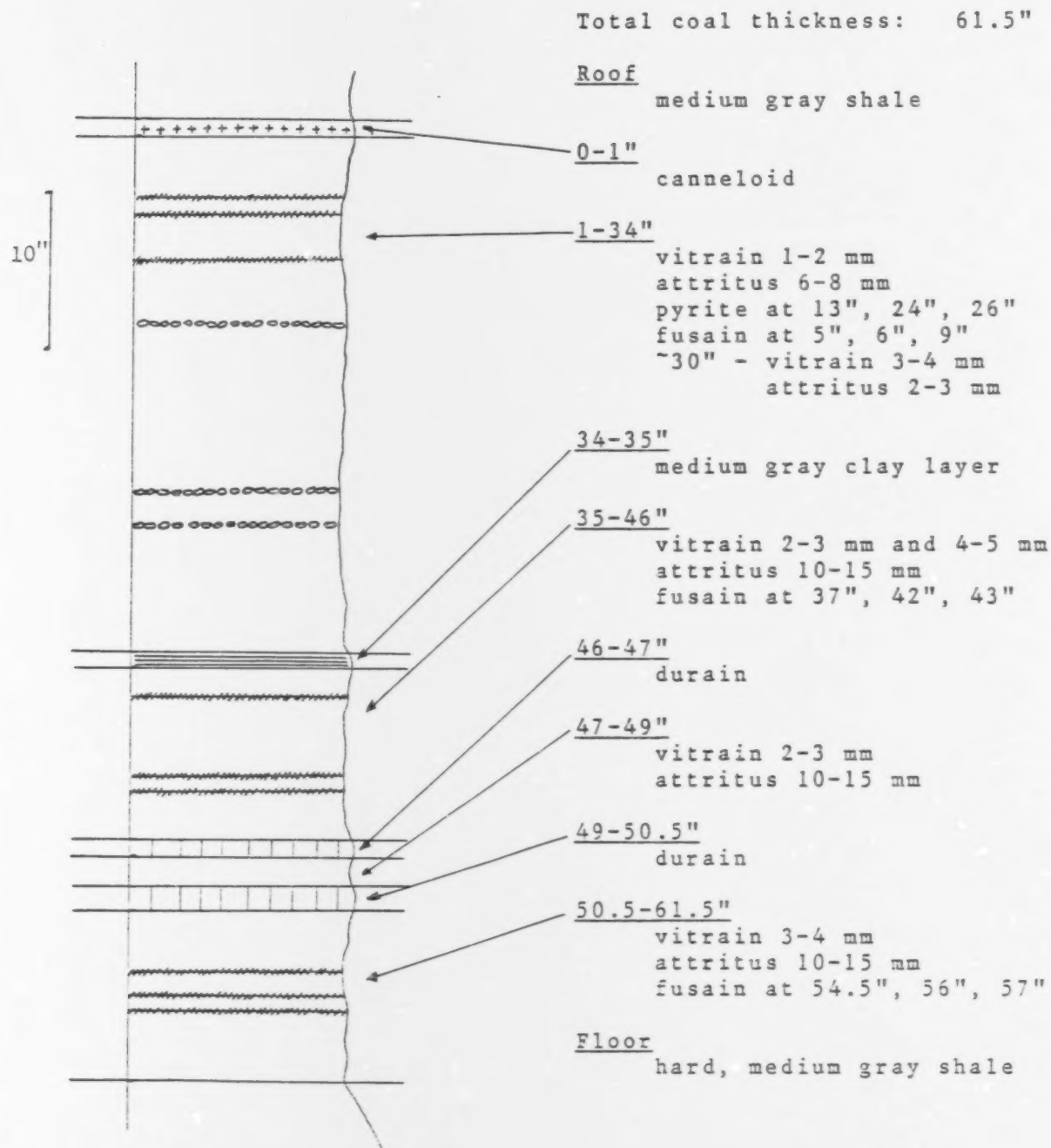


Figure 4b. In-mine description of channel #1 (3 South, 1983) collected near core #2584.

3,4,5-3 South (Core hole) 1983

(1" cannel coal not sampled at top.)

Total coal thickness: 62"

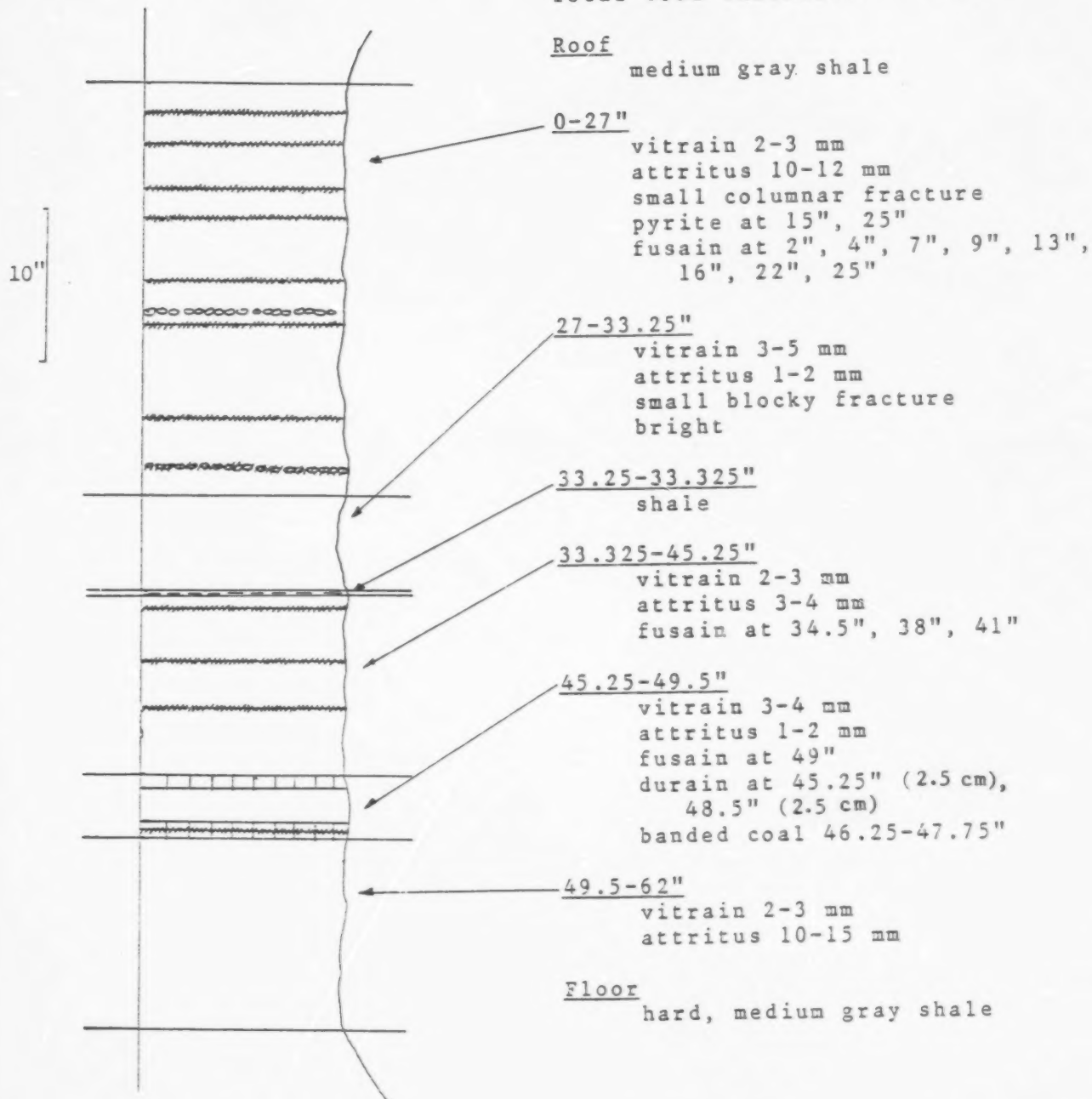


Figure 4c. In-mine description of channels #3,4,5 (3 South, 1983) collected at core #2584.

Total coal thickness: 60.75"

Roof

medium gray shale

0-2"

cannel coal with pyrite

2-27"

vitrain 2-3 mm
attritus 15-20 mm
columnar fracture
pyrite at 5.5", 8", 13"
fusain at 5", 8", 12", 17",
21.5", 26"

27-34"

vitrain 3-4 mm
attritus 1-2 mm
fusain at 27.5", 30.5", 33.5"

34-34.25"

clay

34.25-45"

vitrain 2-3 mm
attritus 10-12 mm
hard blocky fracture
fusain at 38"

45-49.5"

45-46" - durain
46-48" - banded coal
vitrain 3-4 mm
attritus 1-2 mm
48-49.5" - durain
vitrain spars 2-3 mm

49.5-60.75"

vitrain 3-4 mm
attritus 1-2 mm
fusain at 52"

Floor

hard, medium gray shale

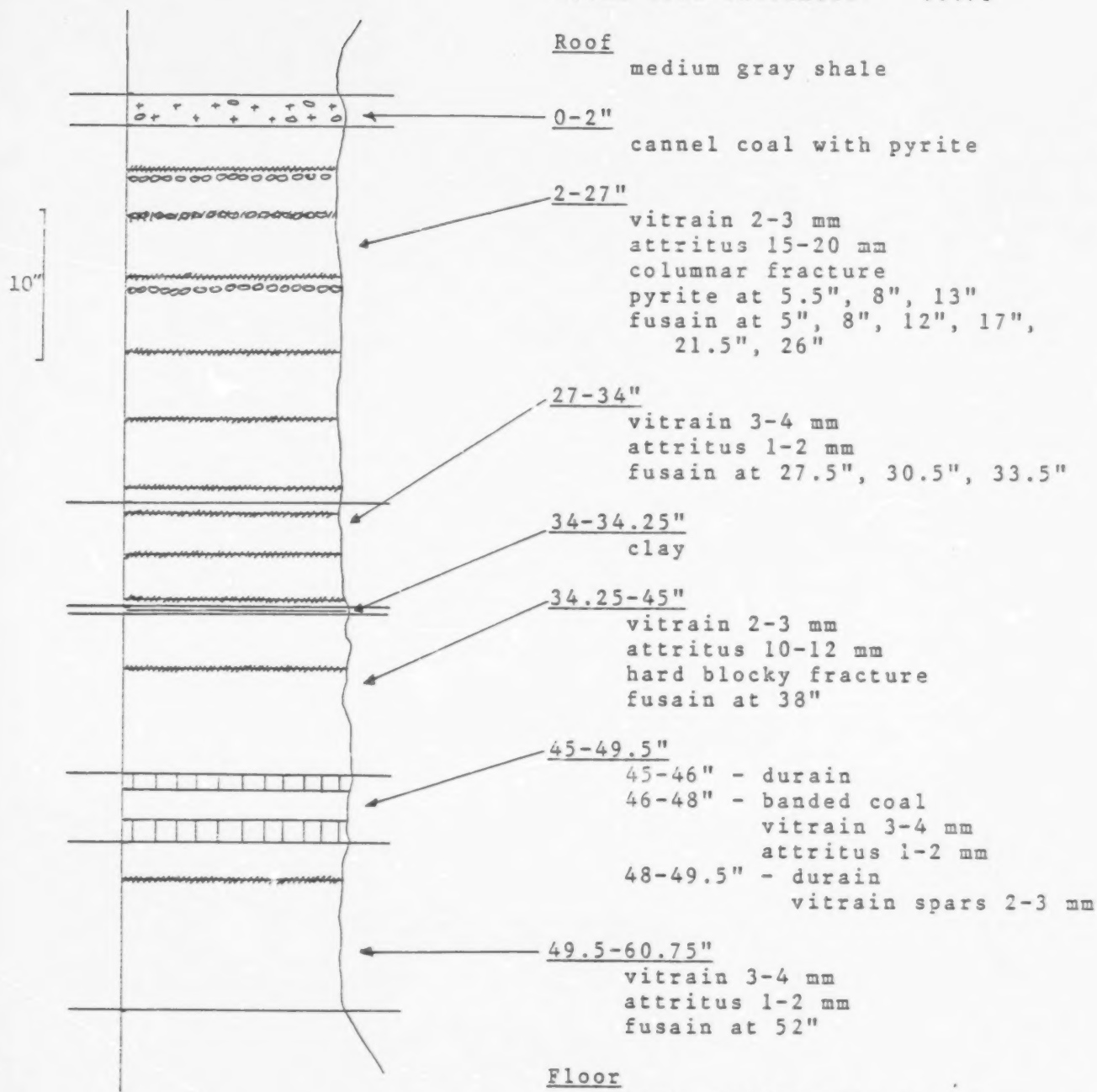


Figure 4d. In-mine description of channel #6 (3 South, 1983) collected near core #2584.

Total coal thickness: 60.25"

Roof

medium gray shale

0-0.5"

canneloid

0.5-26.5"

vitrain 3-4 mm
attritus 10-15 mm
hard, columnar fracture
pyrite at 2", 3", 15", 24"
fusain at 25"
shale lenses at 12", 13"
dull

26.5-32"

no description

32-43.75"

vitrain 2-3 mm
attritus 3-4 mm
large blocky fracture
bright

43.75-48"

vitrain 2-3 mm
attritus 1-2 mm
durain at 43.75-44.75" and 47-48"

48-60.25"

vitrain 2-3 mm
attritus 10-12 mm

Floor

hard, medium gray shale

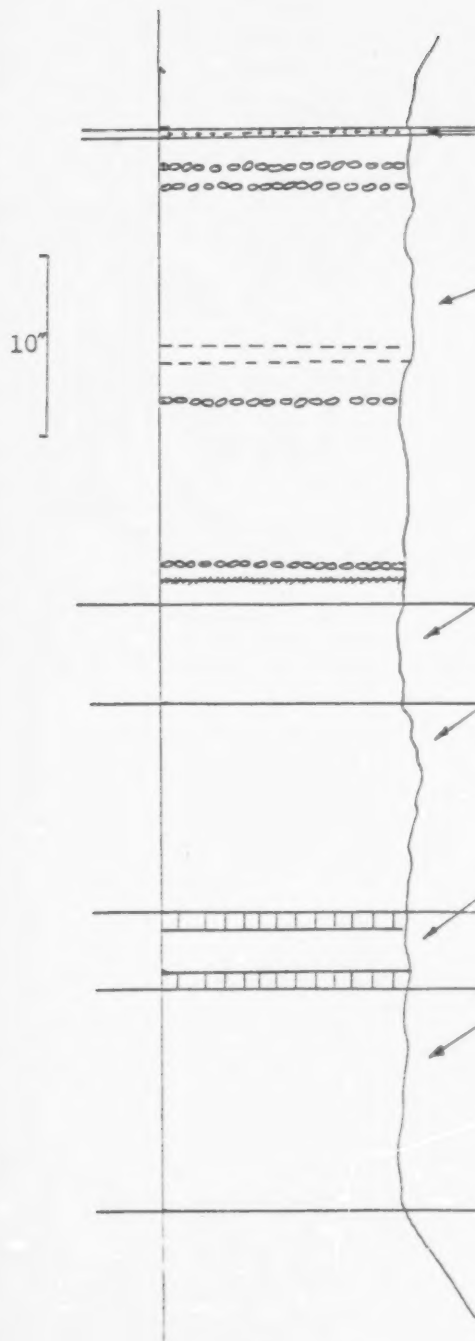


Figure 4e. In-mine description of channel #7 (3 South, 1983) collected near core #2584.

(1/2" canneloid coal not sampled at top.)

Total coal thickness: 61.5"

Roof

medium gray shale

0-24"

vitrain 1-2 mm
attritus 8-10 mm
pyrite at 15", 19", 22"
fusain at 4", 9", 11"
banded

24-34"

vitrain 3-4 mm
attritus 1-2 mm
hard large blocky fracture
pyrite at 25", 29"
fusain at 28"
bright

34-34.5"

shale

34.5-46"

durain at 34.5-35"

46-51"

vitrain 3-4 mm
attritus 1-2 mm
durain 1.3 cm

51-61.5"

fusain at 52" (1.3cm thick) and
56" (1.3cm thick)

Floor

hard, medium gray shale

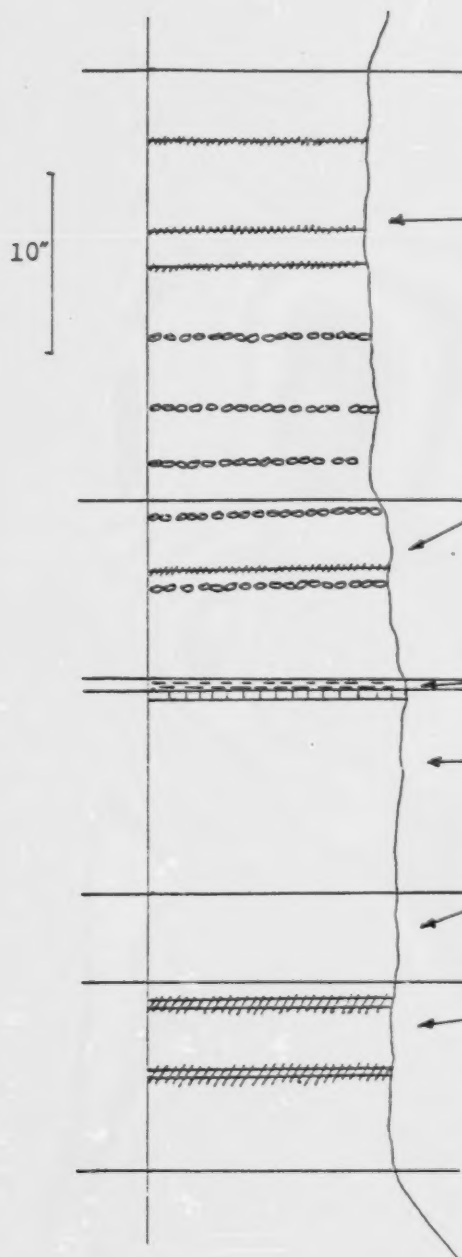
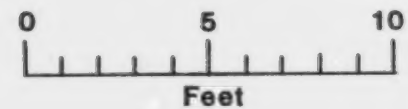


Figure 4f. In-mine description of channel #8 (3 South, 1983) collected near core #2584.

5 SOUTH, 1983

⊕ DH 2585

■ Channel sample



■ 6-5 S

3-5 S ■

⊕ ■ 4-5 S

■ 5-5 S

■ 8-5 S

■ 1-5 S

7-5 S ■

Figure 5a. Location of channel descriptions in 5 South and core #2585, 1983 sampling.

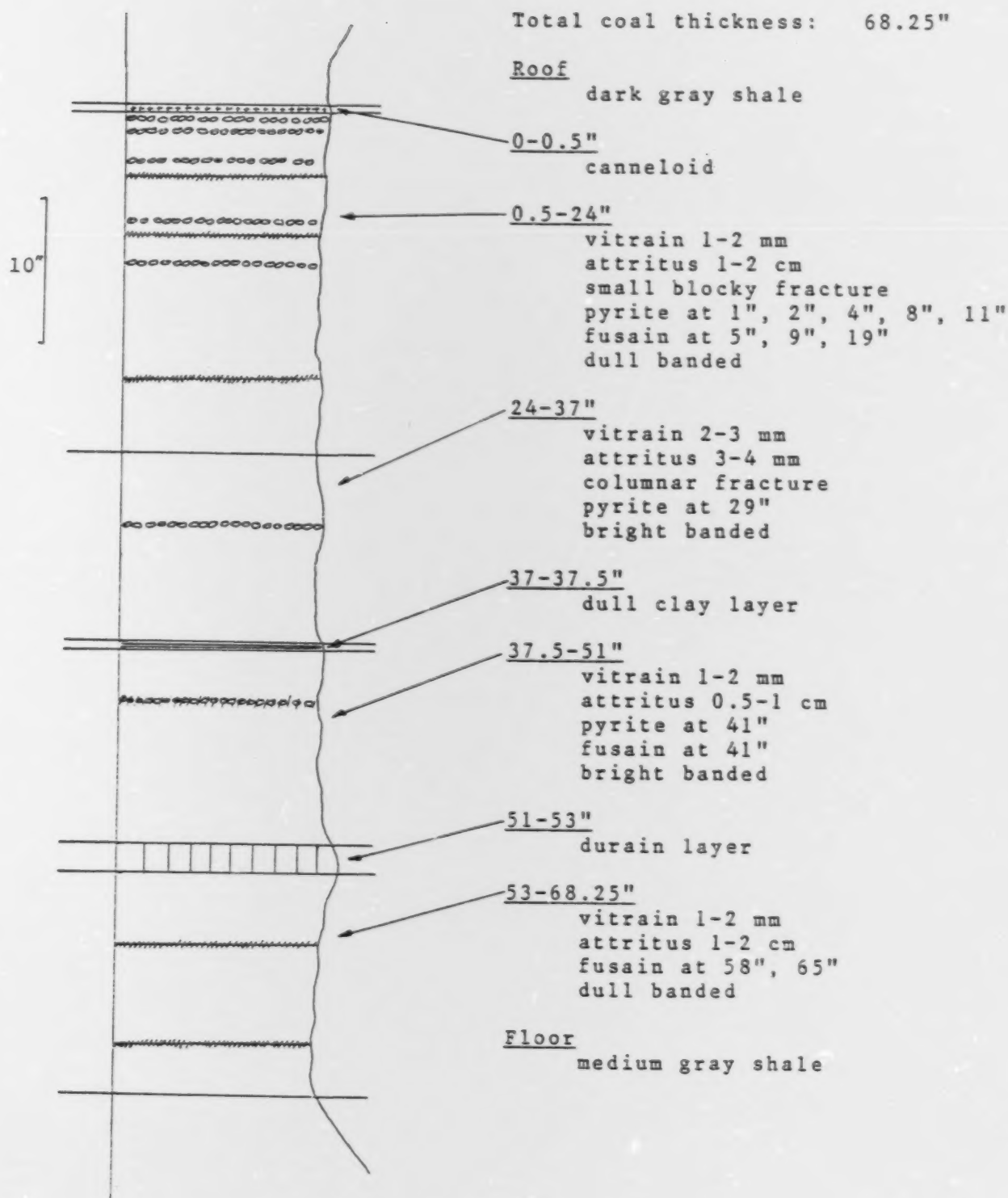


Figure 5b. In-mine description of channel #1 (5 South, 1983) collected near core #2585.

Total coal thickness: 65.75"

Roof

dark gray shale

0-0.5"

canneloid

0.5-24"

vitrain 1 mm

attritus 2-3 cm

pyrite at 2", 3", 5", 12", 20"

fusain at 3", 4", 6", 9", 16"

dull banded

24-47"

vitrain 3-4 mm

attritus 2-3 mm

fusain at 31", 35" (with clay),

39", 43"

bright banded

47-63"

vitrain 3-4 mm

attritus 5-6 mm

hard blocky fracture

fusain at 54", 59"

durain 47-47.5"

dull

63-63.75"

durain

63.75-65.75"

coal - no description

Floor

medium gray shale

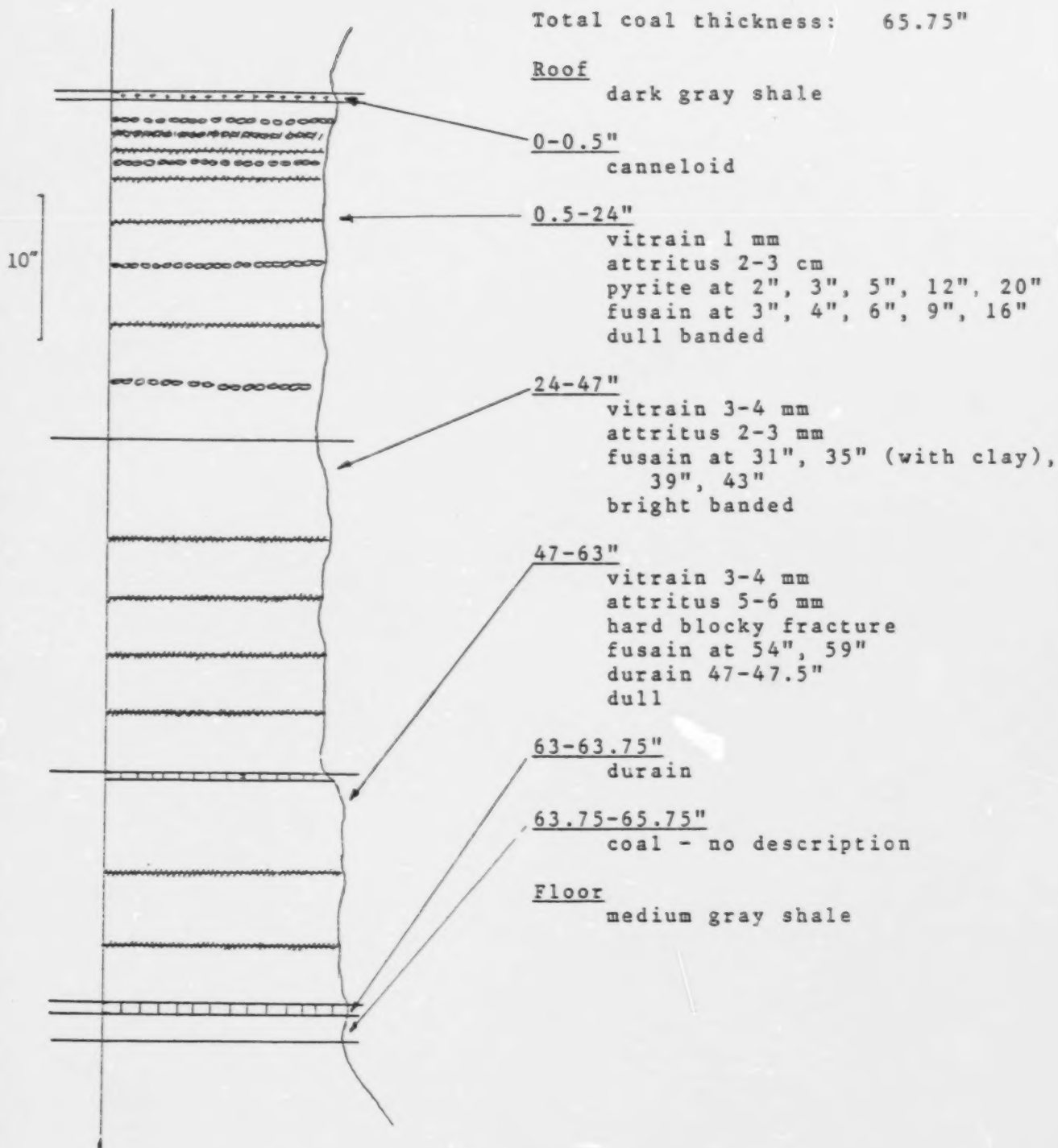


Figure 5c. In-mine description of channels #3,4,5 (5 South, 1983) collected at core #2585.

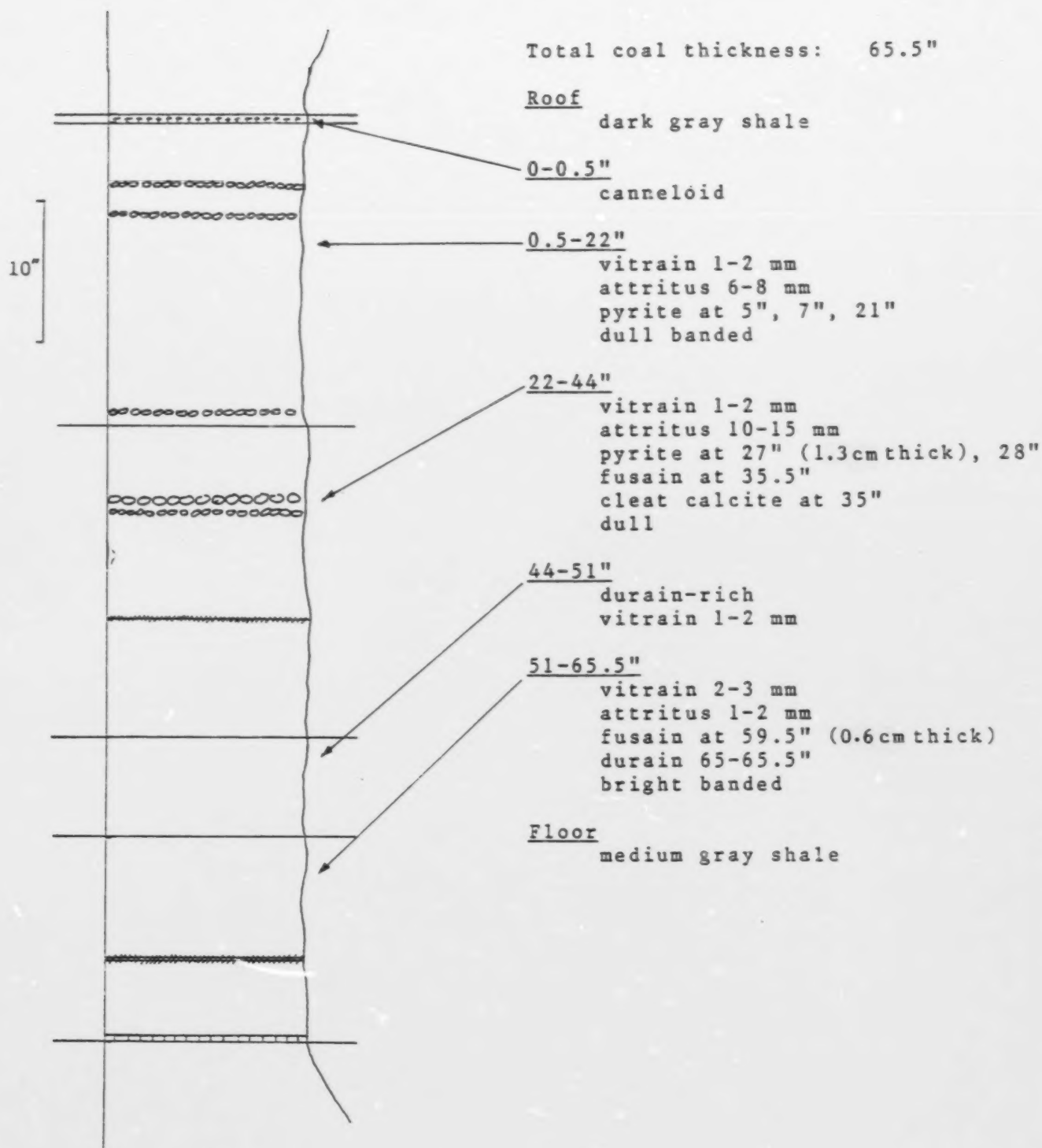


Figure 5d. In-mine description of channel #6 (5 South, 1983) collected near core #2585.

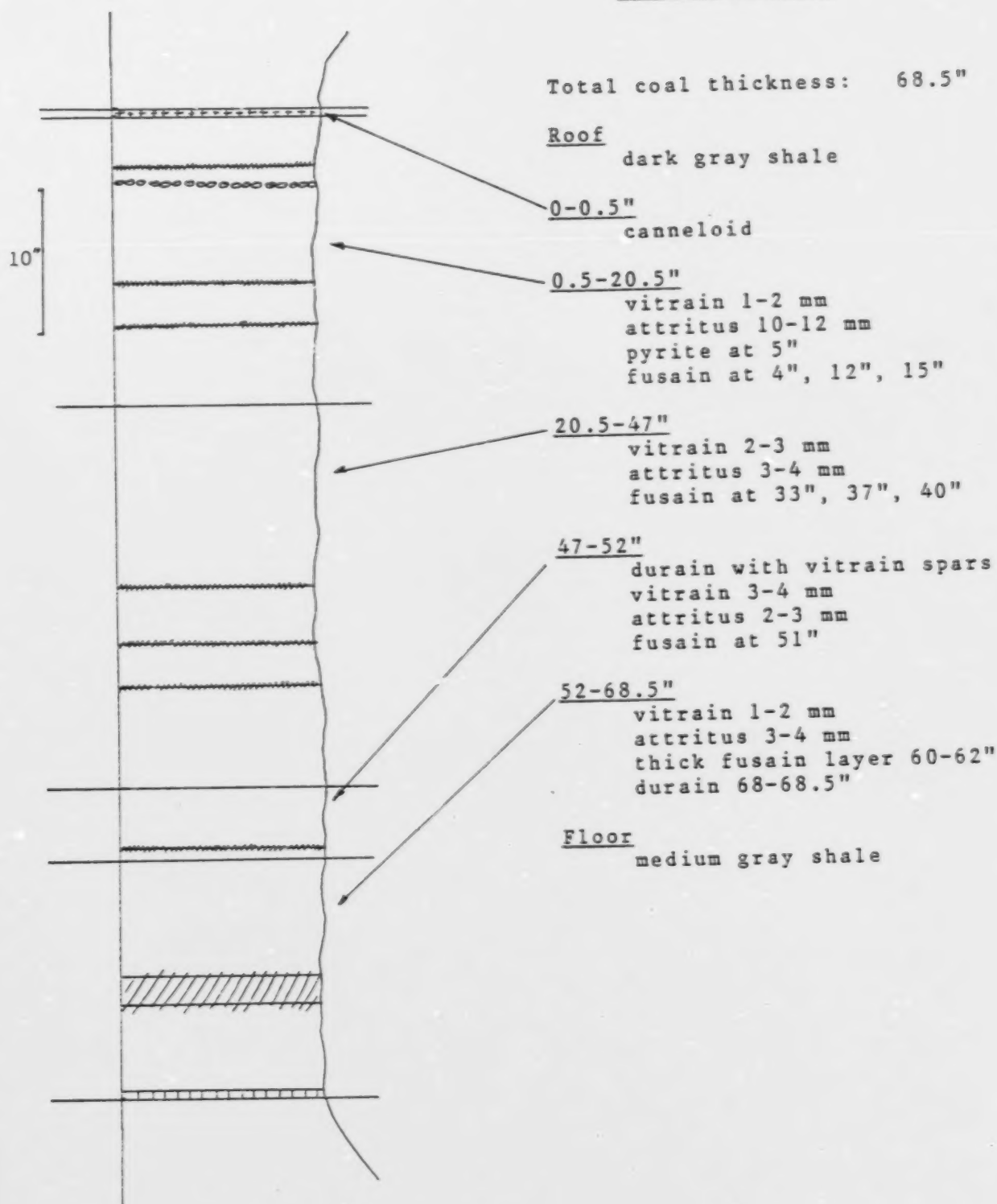


Figure 5e. In-mine description of channel #7 (5 South, 1983) collected near core #2585.

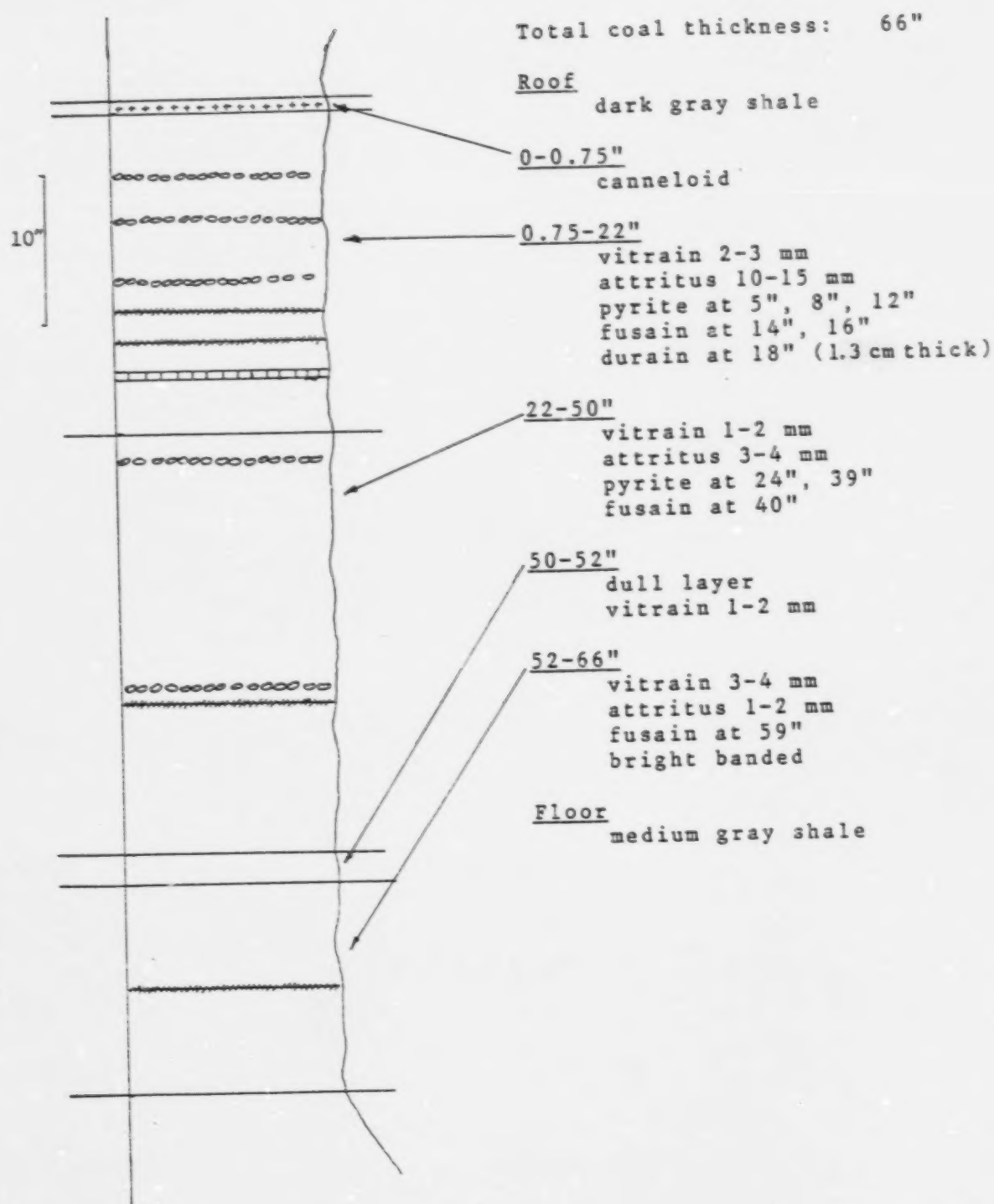


Figure 5f. In-mine description of channel #8 (5 South, 1983) collected near core #2585.

3 SOUTH, 1984

⊕ DH 2715

■ Channel sample



■ 9-3 S

6-3 S



4-3 S ■

5-3 S ■ ⊕ ■ 7-3 S



■ 3-3 S

Figure 6a. Location of channel descriptions in 3 South and core #2715, 1984 sampling.

1-3 South 1984

Total coal thickness: 62.5"

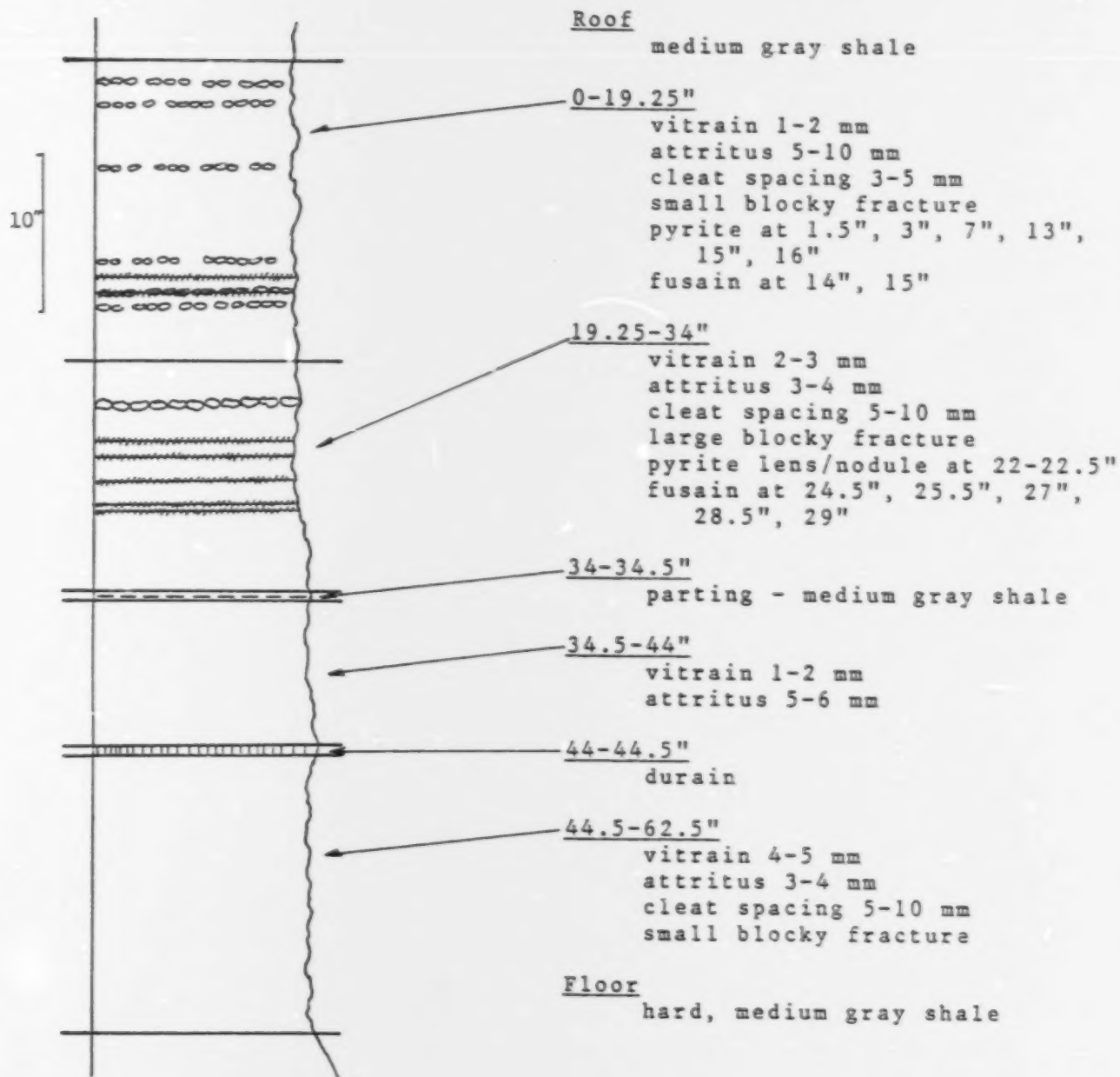


Figure 6b. In-mine description of channel #1 (3 South, 1984) collected near core #2715.

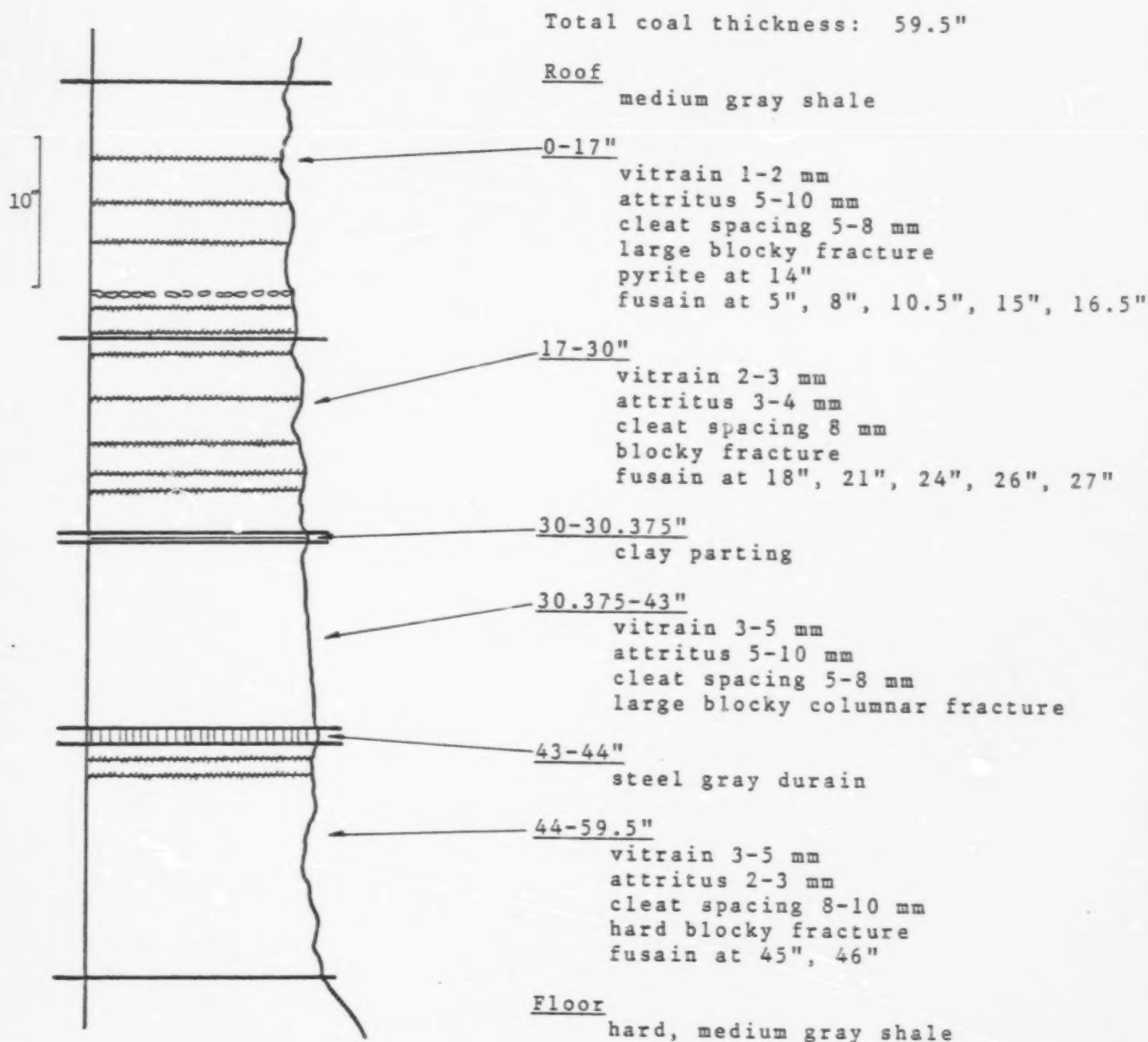
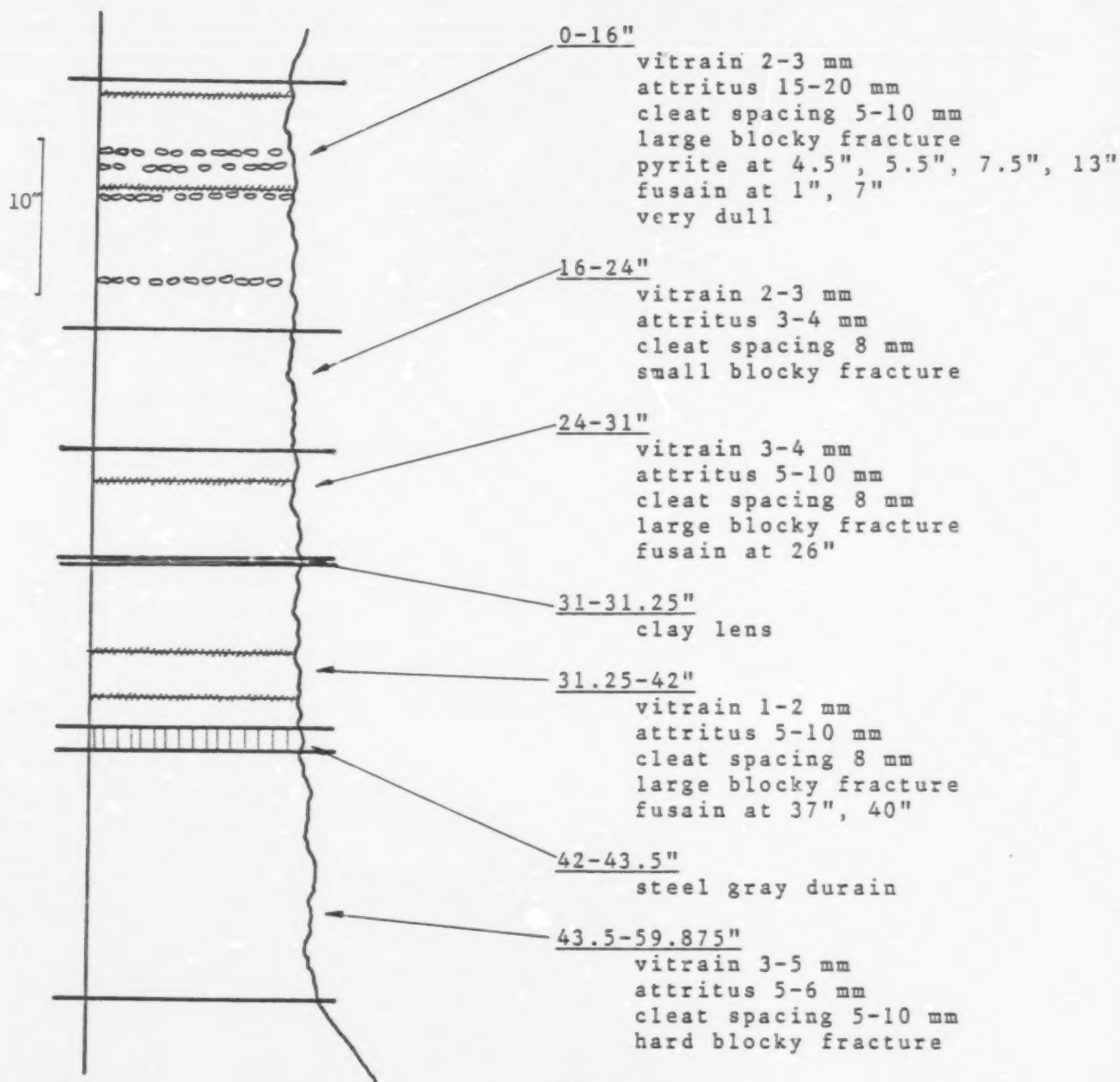


Figure 6c. In-mine description of channel #2 (3 South, 1984) collected near core #2715.

Total coal thickness: 59.875"

Roof

medium gray shale



Floor

hard, medium gray shale

Figure 6d. In-mine description of channel #3 (3 South, 1984) collected near core #2715.

Total coal thickness: 63"

Roof

medium gray shale

0-17"

vitrain 2-3 mm
attritus 3-10 mm
small blocky fracture
pyrite at 2", 3.5", 3.75", 4", 4.25"
9"

17-23.75"

vitrain 2-4 mm
attritus 4-9 mm
small blocky fracture
pyrite at 17.5"
fusain at 18", 19", 22"

23.75-31"

vitrain 1-3 mm
attritus 2-6 mm
small blocky fracture

31-32"

clay vein with pyrite

32-43.5"

vitrain 0.5-3 mm
attritus 2-6 mm
clay vein at 38.5" (0.6 cm thick)

43.5-44.5"

steel gray durain

44.5-63"

vitrain 2-5 mm
attritus 2-5 mm
small blocky fracture

Floor

hard, medium gray shale

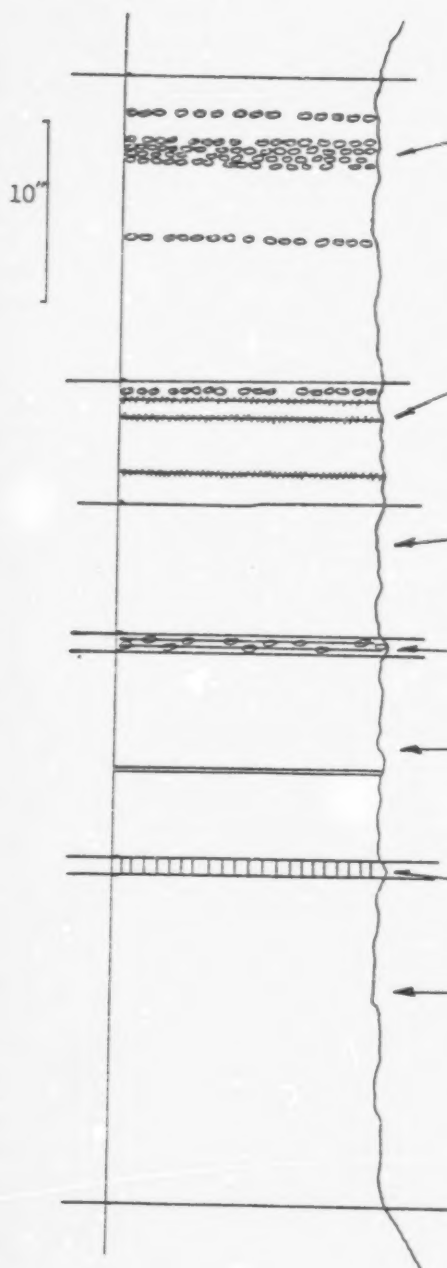


Figure 6e. In-mine description of channel #4 (3 South, 1984) collected near core #2715.

■ 4-4 S

■ 5-4 S



N

■ 3-4 S

4 SOUTH, 1984

⊕ DH 2717
■ Channel sample



Figure 7a. Location of channel descriptions in 4 South and core #2717, 1984 sampling.

1-4 South 1984

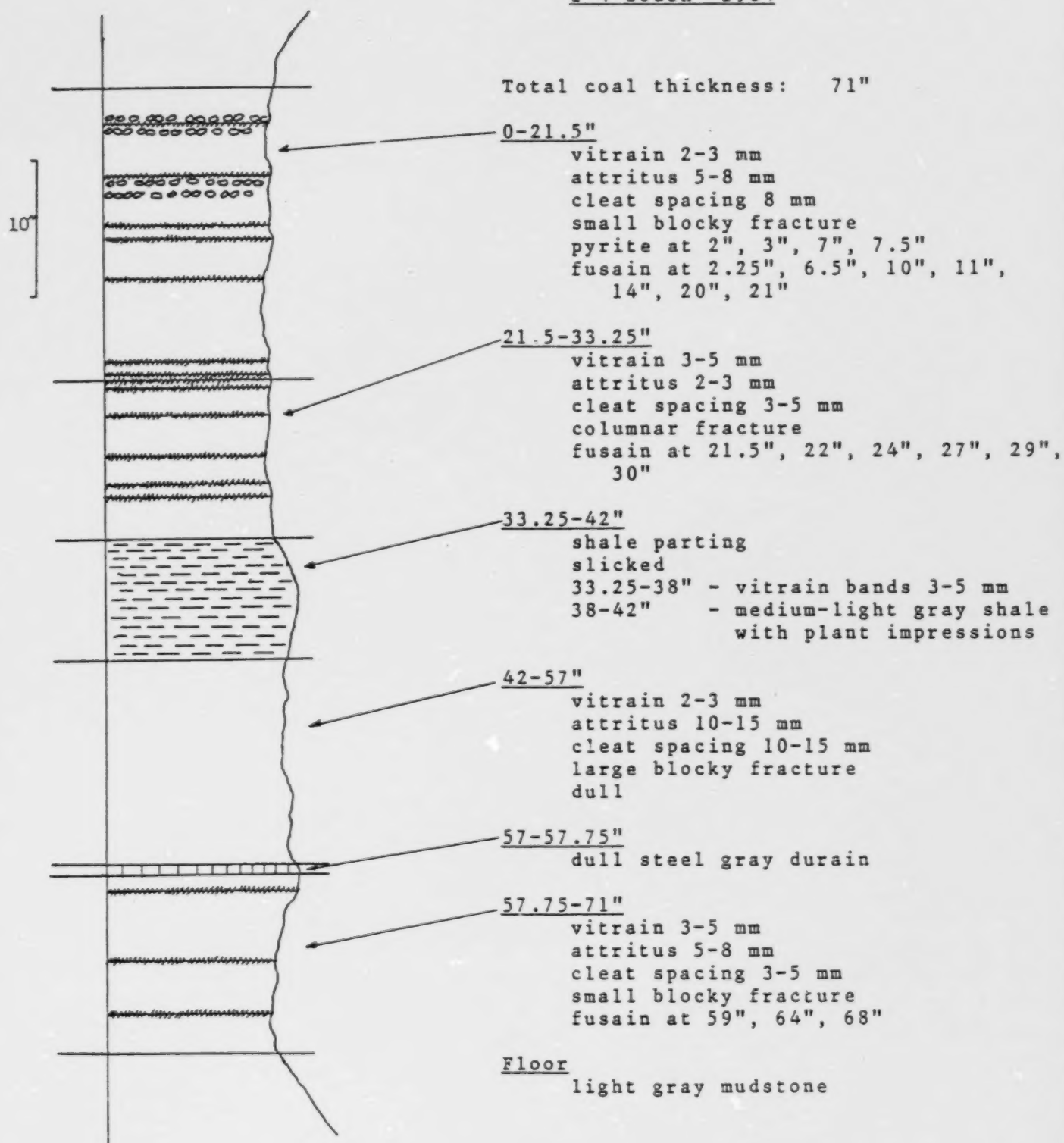


Figure 7b. In-mine description of channel #1 (4 South, 1984) collected near core #2717.

2-4 South 1984

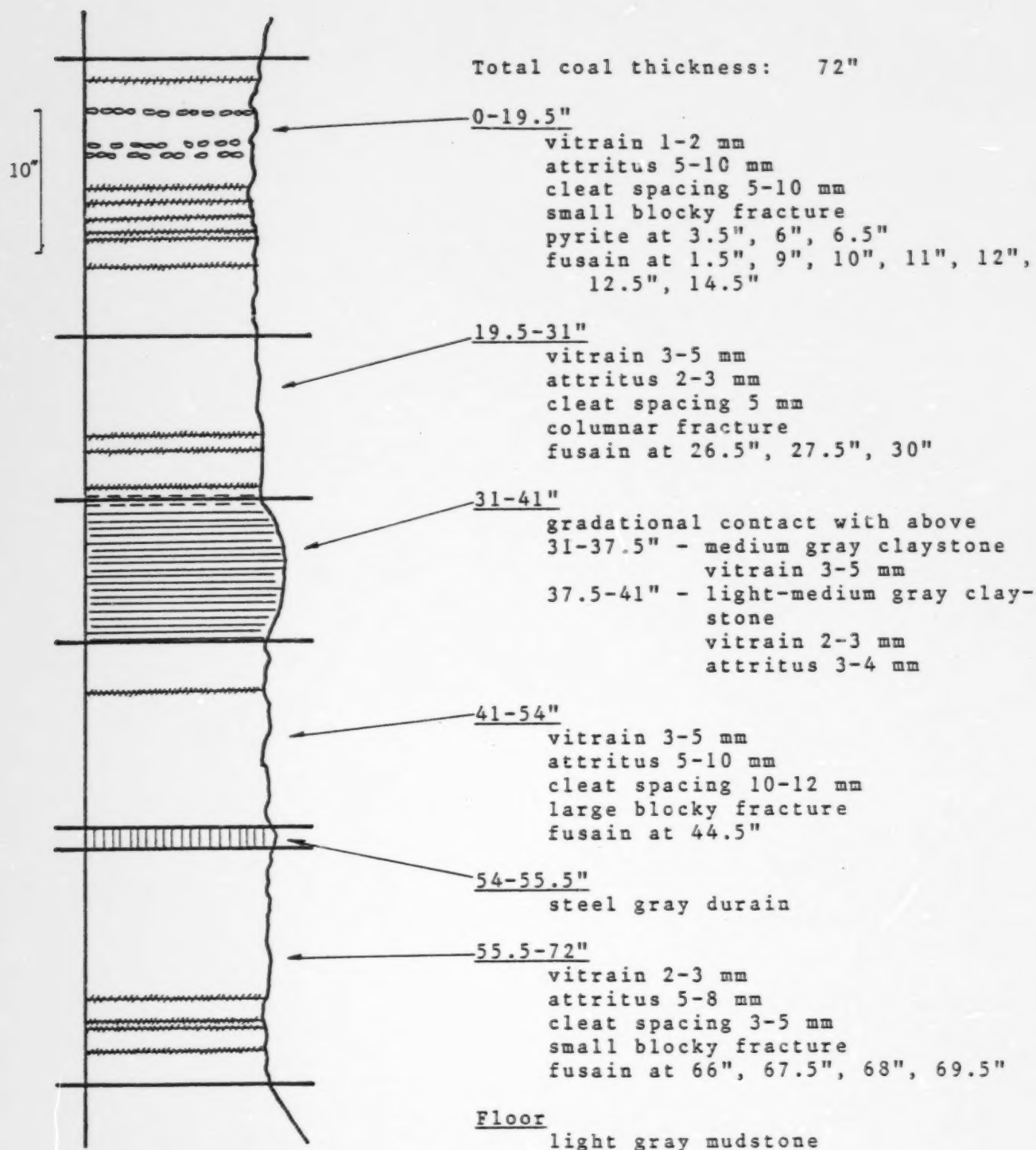


Figure 7c. In-mine description of channel #2 (4 South, 1984) collected near core #2717.

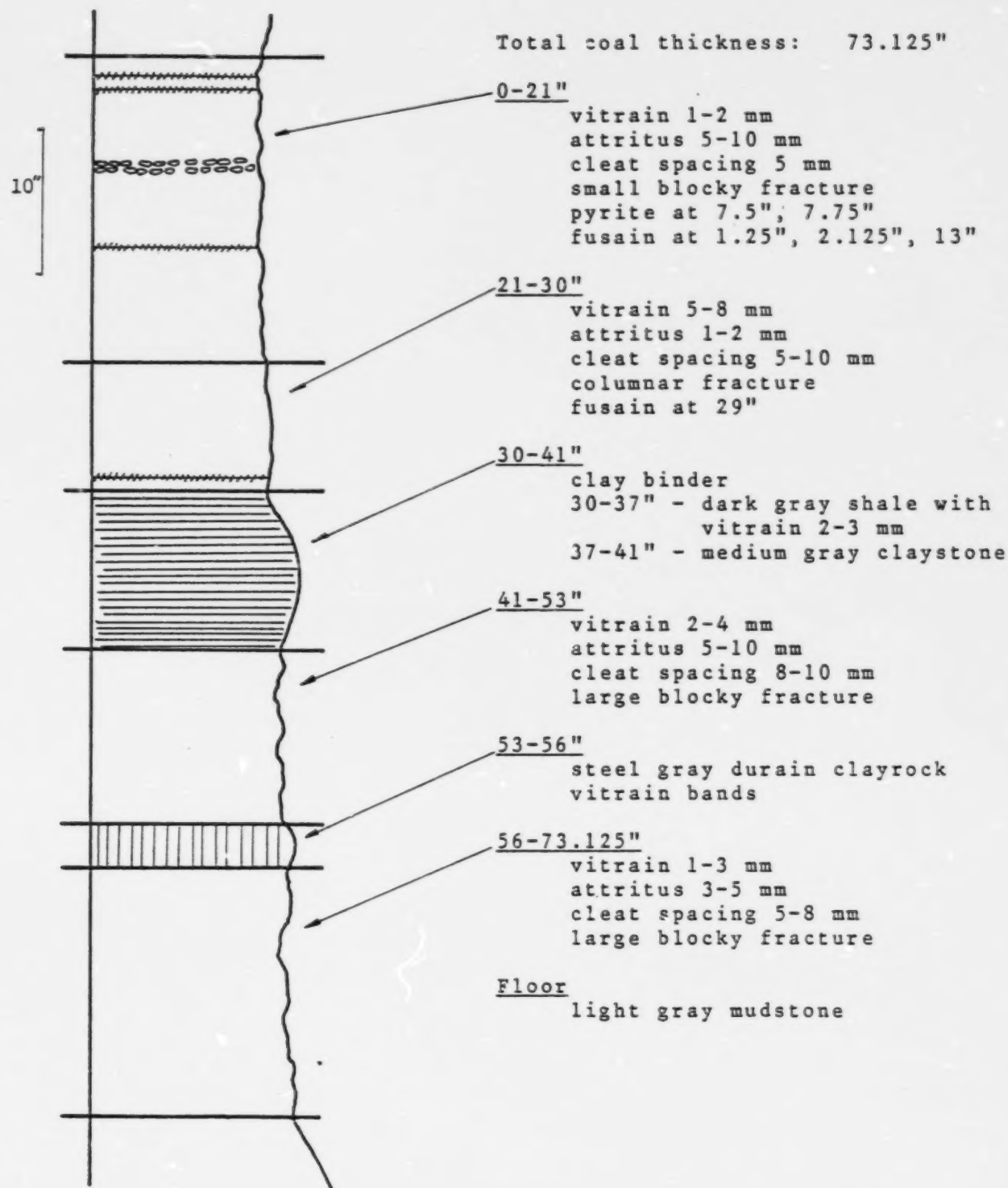


Figure 7d. In-mine description of channel #3 (4 South, 1984) collected near core #2717.

4 NORTH, 1984

⊕ DH 2716

■ Channel sample



■ 4-4 N

■ 5-4 N

⊕

■ 3-4 N

■ 9-4 N



■ 8-4 N

Figure 8a. Location of channel descriptions in 4 North and core #2716, 1984 sampling.

1-4 North 1984

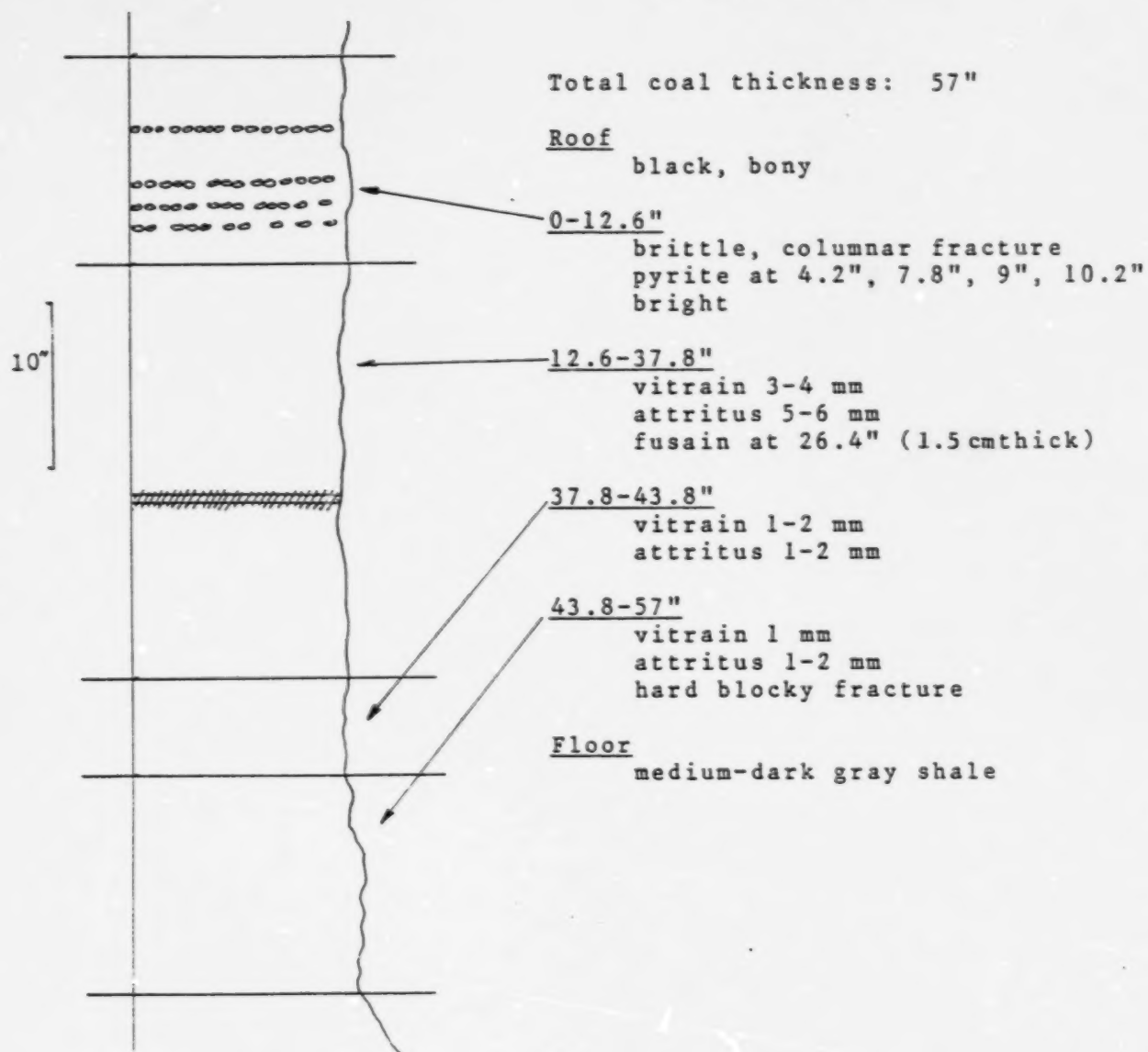


Figure 8b. In-mine description of channel #1 (4 North, 1984) collected near core #2716.

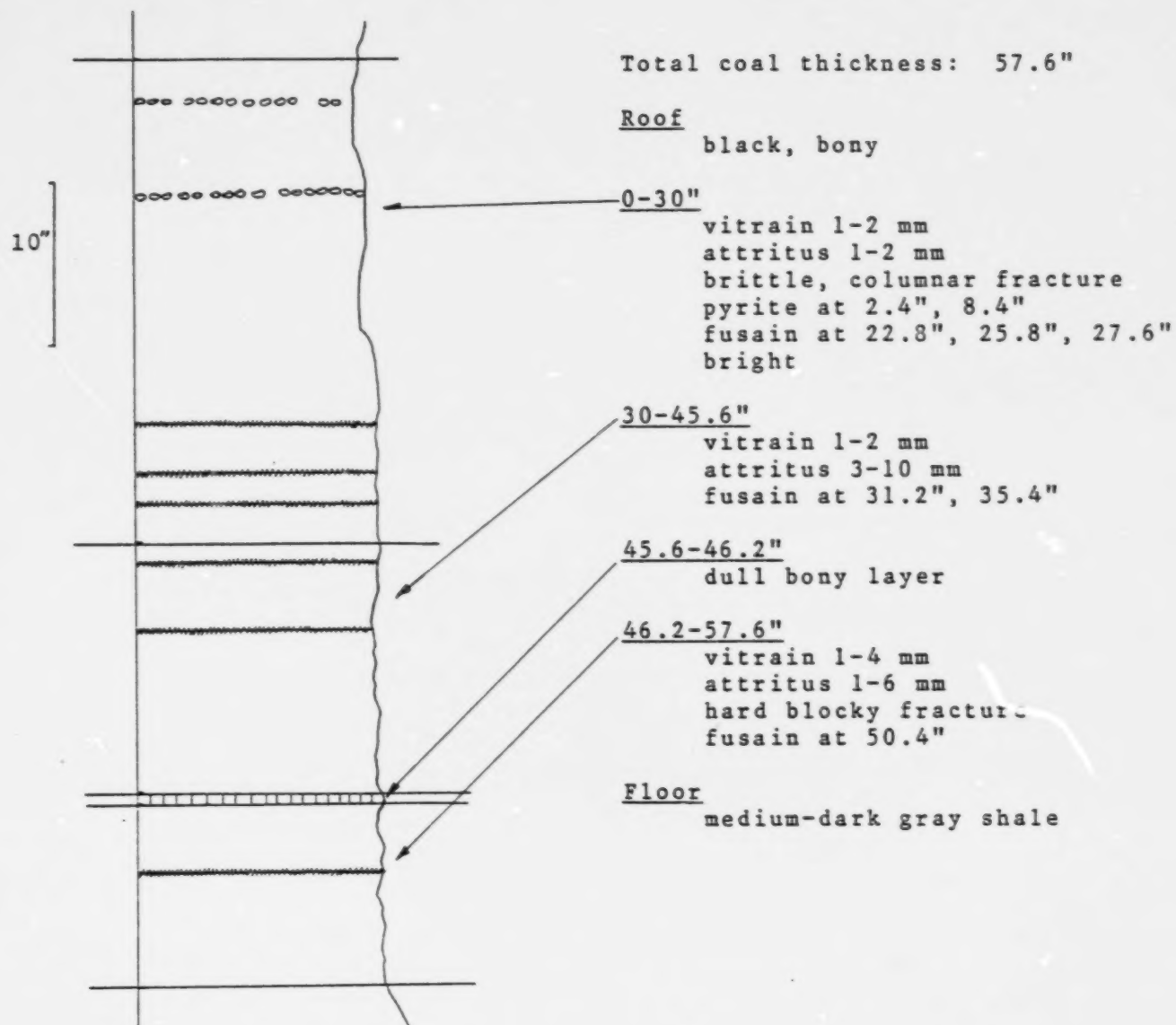


Figure 8c. In-mine description of channel #2 (4 North, 1984) collected near core #2716.

3-4 North 1984

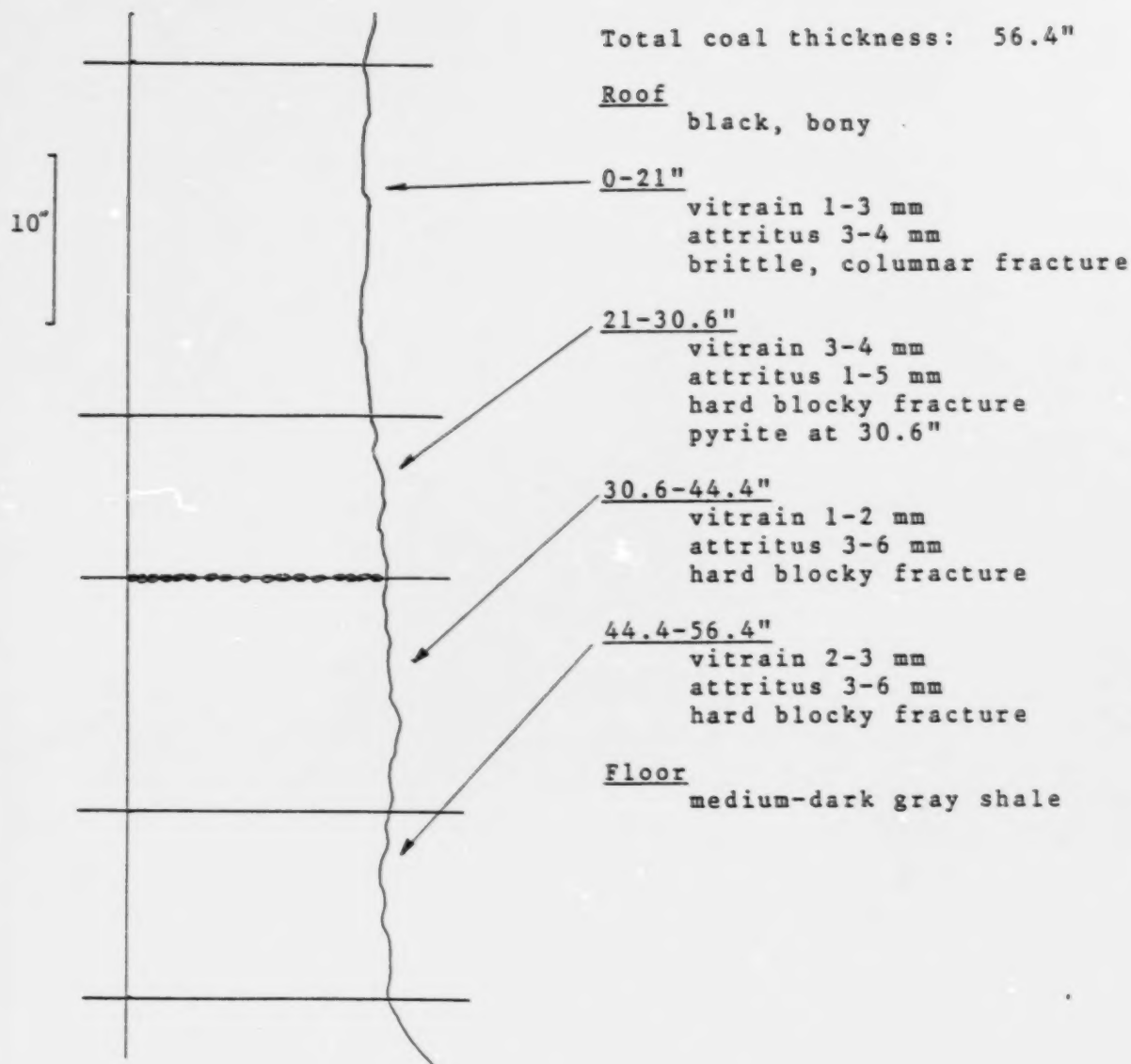


Figure 8d. In-mine description of channel #3 (4 North, 1984) collected near core #2716.



Figure 9a. Location of channel descriptions in 5 South and core #2718, 1984 sampling.

Total coal thickness: 70.2"

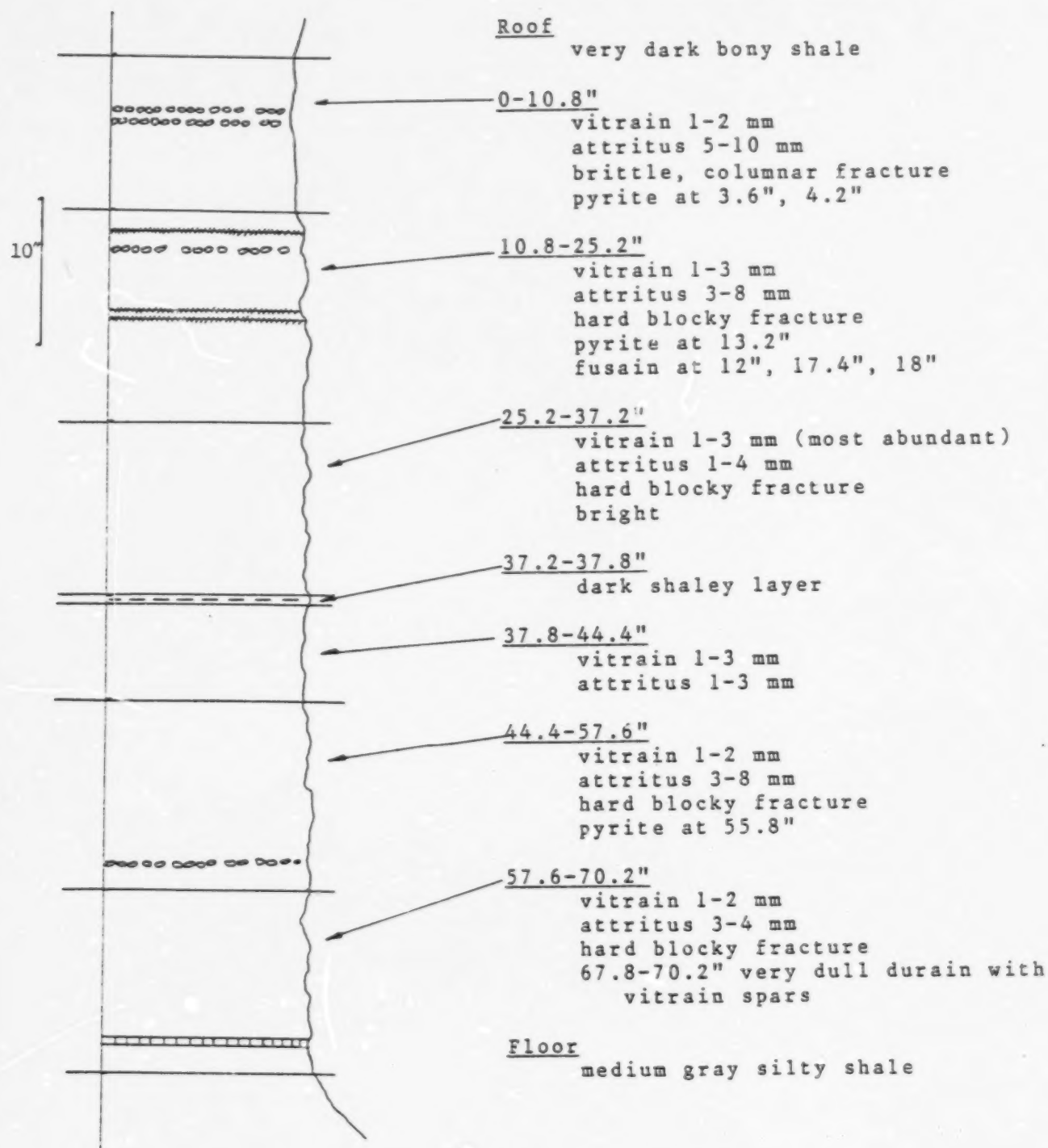
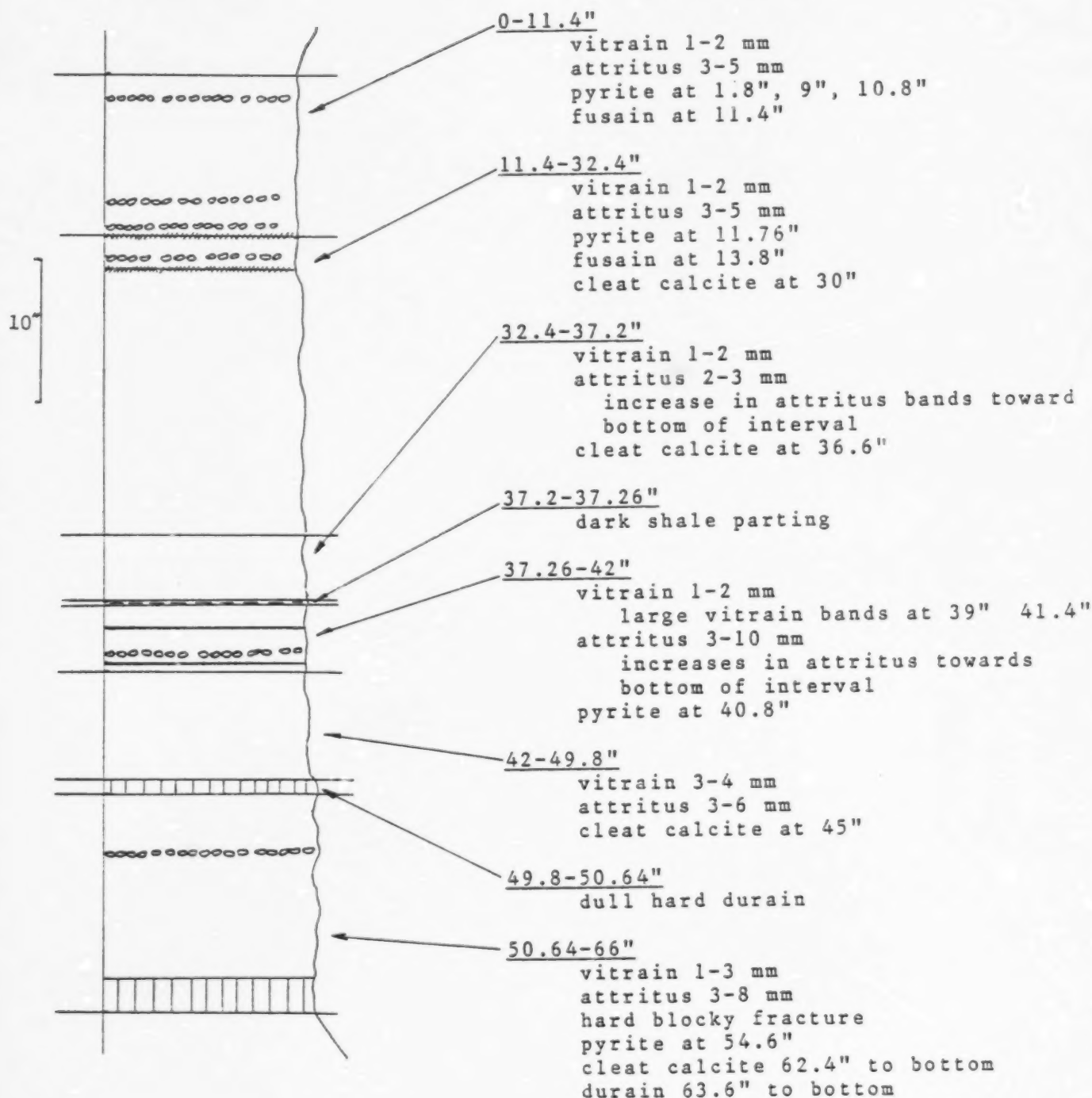


Figure 9b. In-mine description of channel #1 (5 South, 1984) collected near cor. #2718.

Total coal thickness: 66"

Roof

dark bony shale

Floor

medium gray shale

Figure 9c. In-mine description of channel #2 (5 South, 1984) collected near core #2718.

3-5 South 1984

Total coal thickness: 69.6"

Roof

dark bony

0-13.2"

vitrain 1-2 mm
attritus 3-6 mm
hard blocky fracture
pyrite at 10.8"

13.2-21"

vitrain 1 mm
attritus 2-4 mm

21-27"

vitrain 1-3 mm
attritus 3-6 mm
hard blocky fracture

27-36"

vitrain 1-3 mm
attritus 1-3 mm
some calcite in cleat
bright

36-42"

shale binder

42-48"

vitrain 1-2 mm
attritus 2-3 mm
pyrite at 42"

48-48.96"

bony layer
carbonaceous
very hard
some vitrain spars

48.96-69.6"

vitrain 1-3 mm
attritus 3-10 mm
pyrite at 57.6", 63"

Floor

medium gray shale

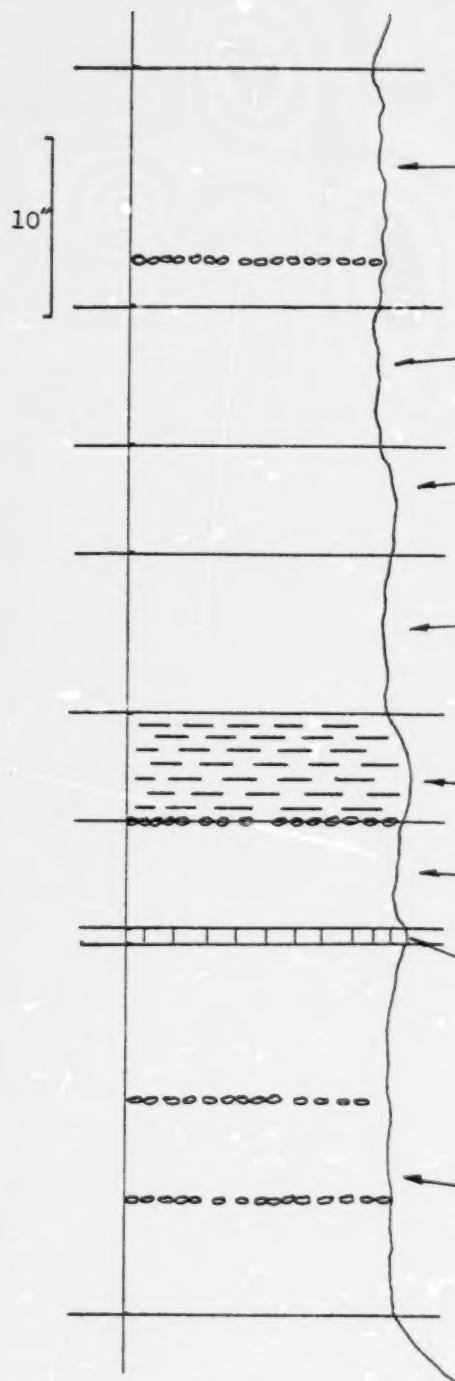


Figure 9d. In-mine description of channel #3 (5 South, 1984) collected near core #2718.

4-5 South 1984

Total coal thickness: 62"

Roof

dark bony shale

0-11.5"

vitrain ~1 mm
attritus 5-10 mm
cleat spacing 1-2 mm
small blocky fracture
pyrite at 4.5", 5", 5.5"
fusain at 2.5", 3", 8.5", 9"
very dull

11.5-34.5"

vitrain 1-5 mm
attritus 1-3 mm
cleat spacing 3-5 mm
columnar fracture
pyrite at 12.5"

34.5-36"

clayshale parting

36-46.5"

vitrain 1-3 mm
attritus 3-6 mm
cleat spacing 5-10 mm
hard blocky fracture

46.5-47.5"

durain parting

47.5-62"

vitrain 1-2 mm
attritus 3-6 mm
cleat spacing 5-10 mm
large blocky fracture

Floor

medium gray shale



Figure 9e. In-mine description of channel #4 (5 South, 1984) collected near core #2718.

5,6,7-5 South 1984

Total coal thickness: 63"

Roof

dark bony shale

0-13"

vitrain 1-2 mm
attritus 3-5 mm
cleat spacing 2-5 mm
small blocky fracture
pyrite at 4.5", 7", 8", 11.5",
12", 12.5", 13"
dull

13-31.5"

vitrain 2-5 mm
attritus 1-2 mm
cleat spacing 3-5 mm
columnar fracture

31.5-32.5"

clayshale parting

32.5-44"

vitrain 1-3 mm
attritus 4-6 mm
cleat spacing 8-10 mm
hard blocky fracture

44-45"

durain parting

45-63"

vitrain 1-3 mm
attritus 4-7 mm
cleat spacing 8-10 mm
large blocky fracture

Floor

medium gray shale

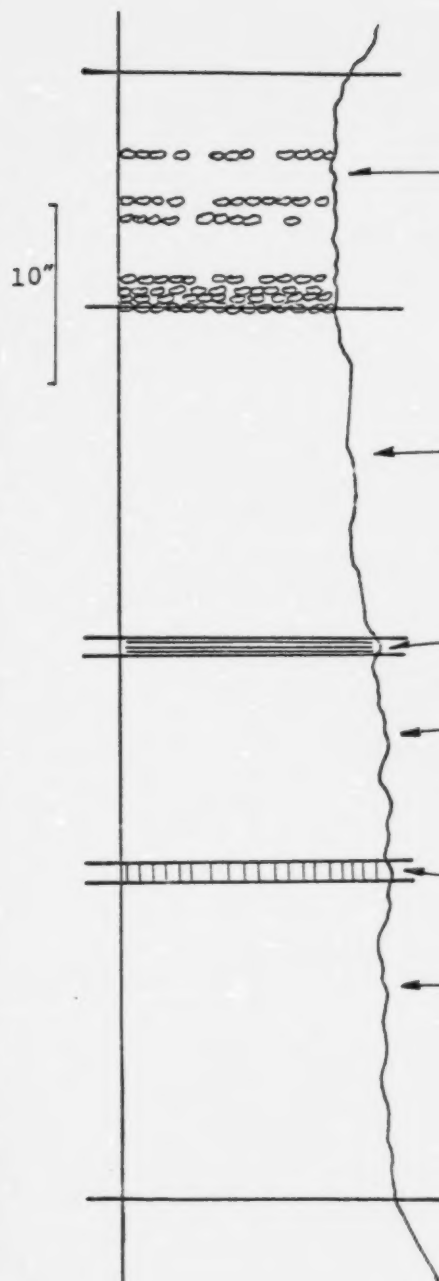


Figure 9f. In-mine description of channels #5,6,7 (5 South, 1984) collected at core #2718.

Total coal thickness: 63"

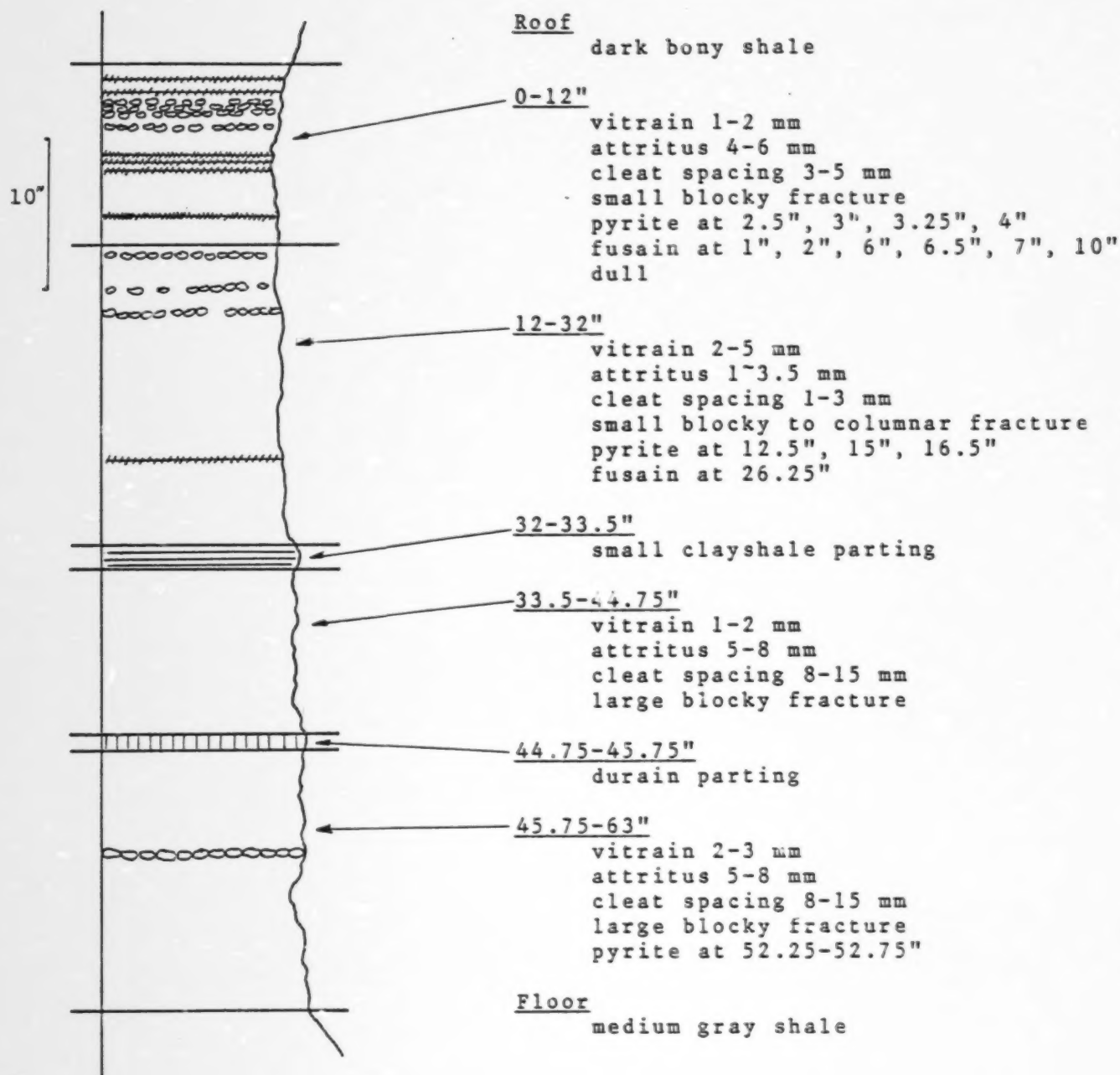


Figure 9g. In-mine description of channel #8 (5 South, 1984) collected near core #2718.

■ 4-WM

■ 5-WM

⊕

■ 8-WM

WEST MAINS, 1984

⊕ DH 2719
■ Channel sample



■ 3-WM

Figure 10a. Location of channel descriptions in West Mains and core #2719, 1984 sampling.

1-West Mains 1984

Total coal thickness: 67.8"

Roof

black bone

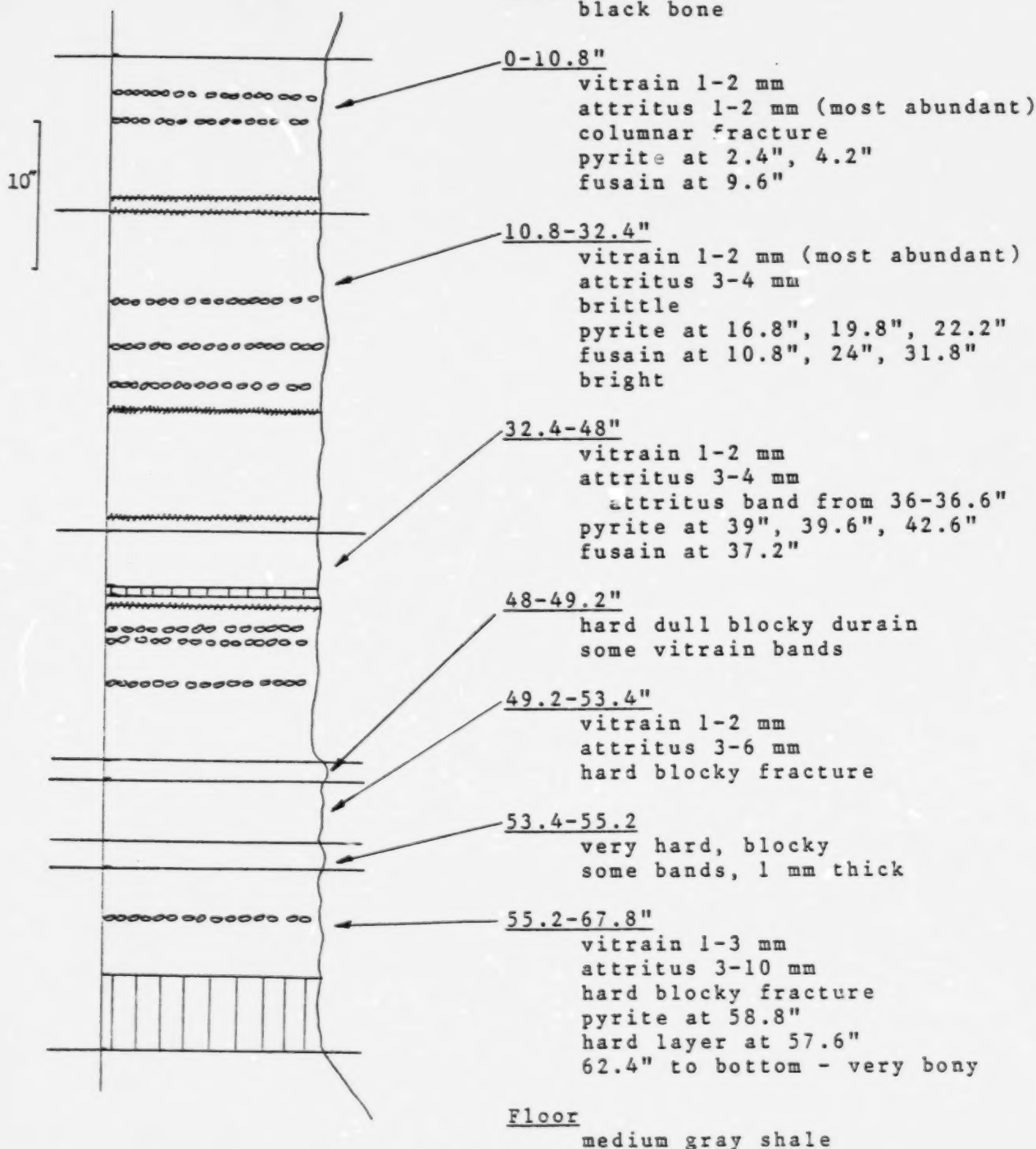


Figure 10b. In-mine description of channel #1 (West Mains, 1984) collected near core #2719.

2-West Mains 1984

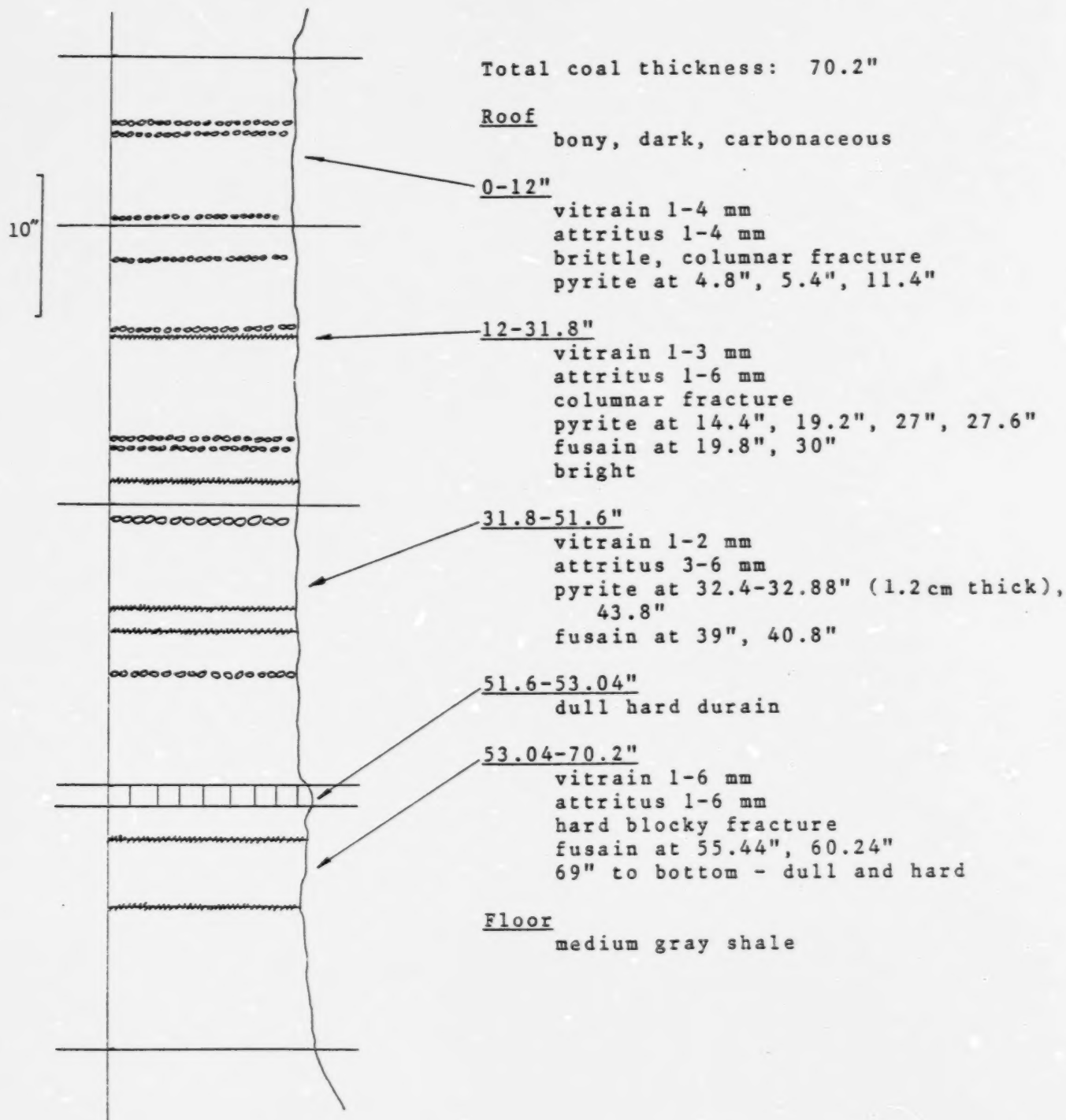


Figure 10c. In-mine description of channel #2 (West Mains, 1984)
collected near core #2719.

3-West Mains 1984

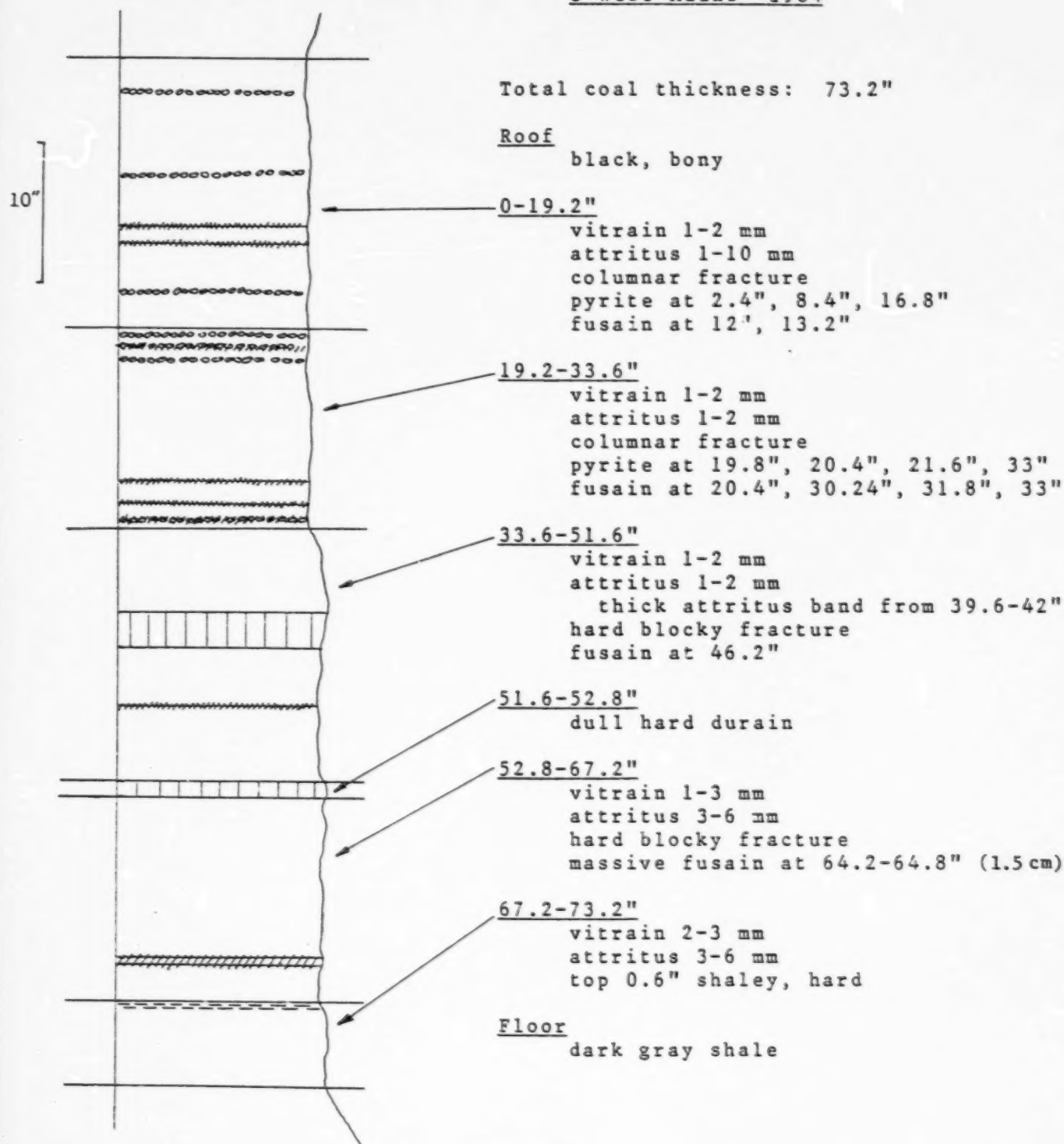


Figure 10d. In-mine description of channel #3 (West Mains, 1984) collected near core #2719.

4-West Mains 1984

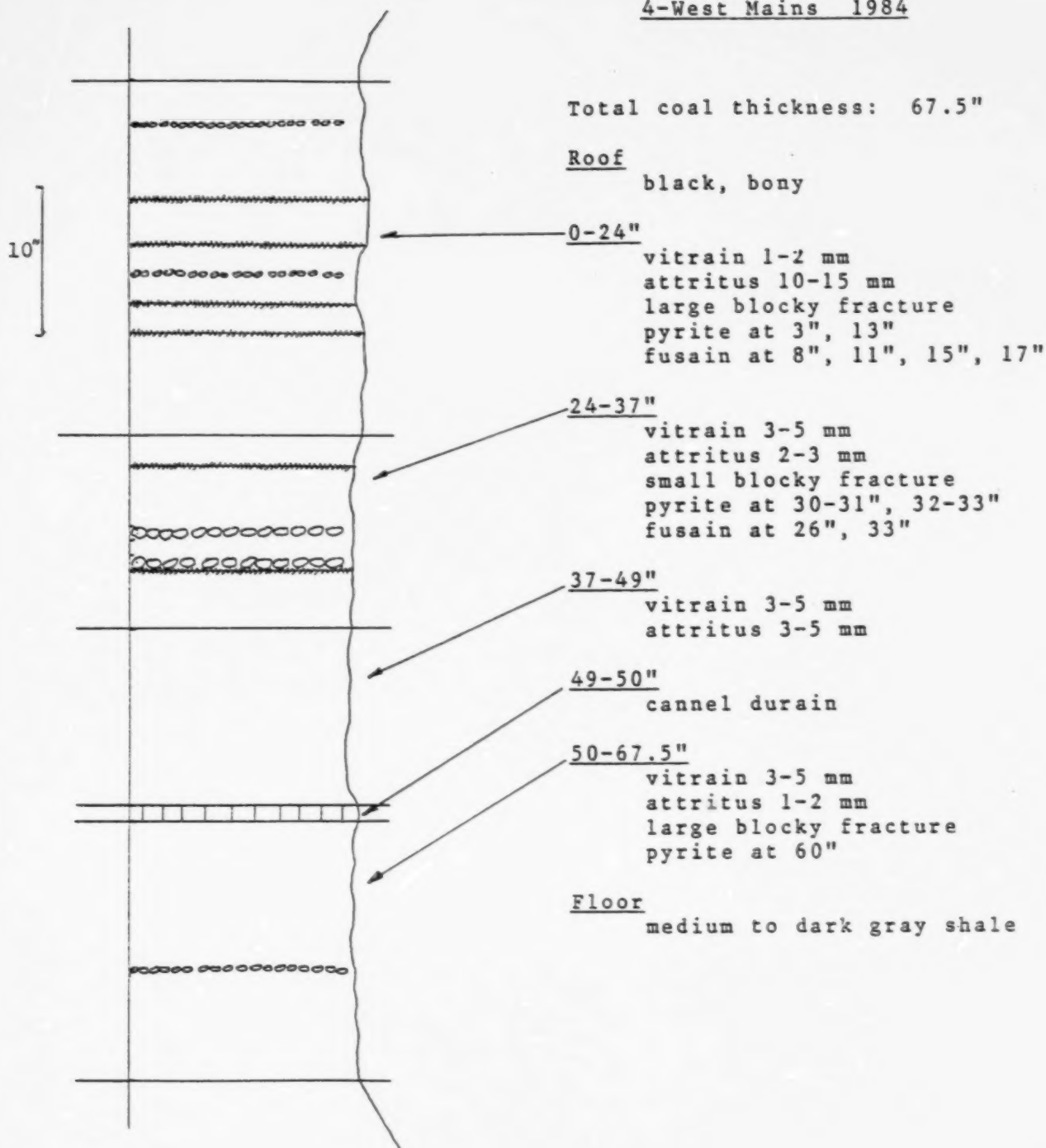


Figure 10e. In-mine description of channel #4 (West Mains, 1984) collected near core #2719.

5.6,7-West Mains 1984

Total coal thickness: 68"

Roof

black, bony

0-24"

vitrain 1-2 mm
attritus 5-10 mm
large blocky fracture
pyrite at 1", 3", 6", 9", 10", 21",
22"
fusain at 5", 9", 10.5", 18"

24-37"

vitrain 3-5 mm
attritus 2-3 mm
small blocky fracture
fusain at 31", 34"

37-50"

vitrain 3-5 mm
attritus 3-5 mm
fusain at 37", 38"

50-51.5"

cannel durain

51.5-68"

vitrain 3-5 mm
attritus 1-2 mm
large blocky fracture
pyrite at 60"

Floor

medium to dark gray shale

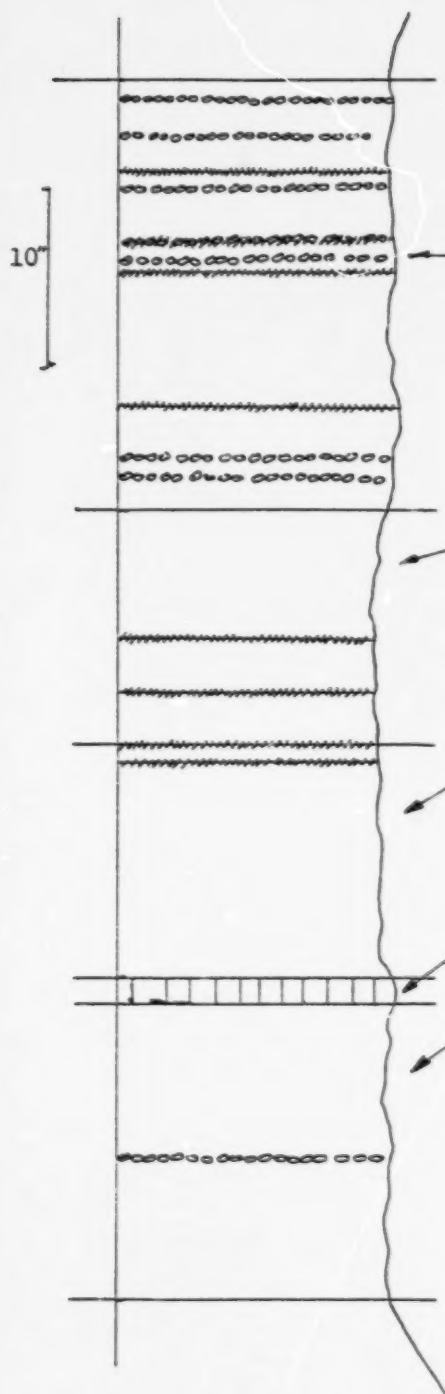


Figure 10f. In-mine description of channels #5,6,7 (West Mains, 1984) collected at core #2719.

6-1 E
5-1 E ■ ⊕ ■ 7-1 E

4-1 E ■

■ 8-1 E

■ 3-1 E



1 EAST, 1984

⊕ DH 2714

■ Channel sample

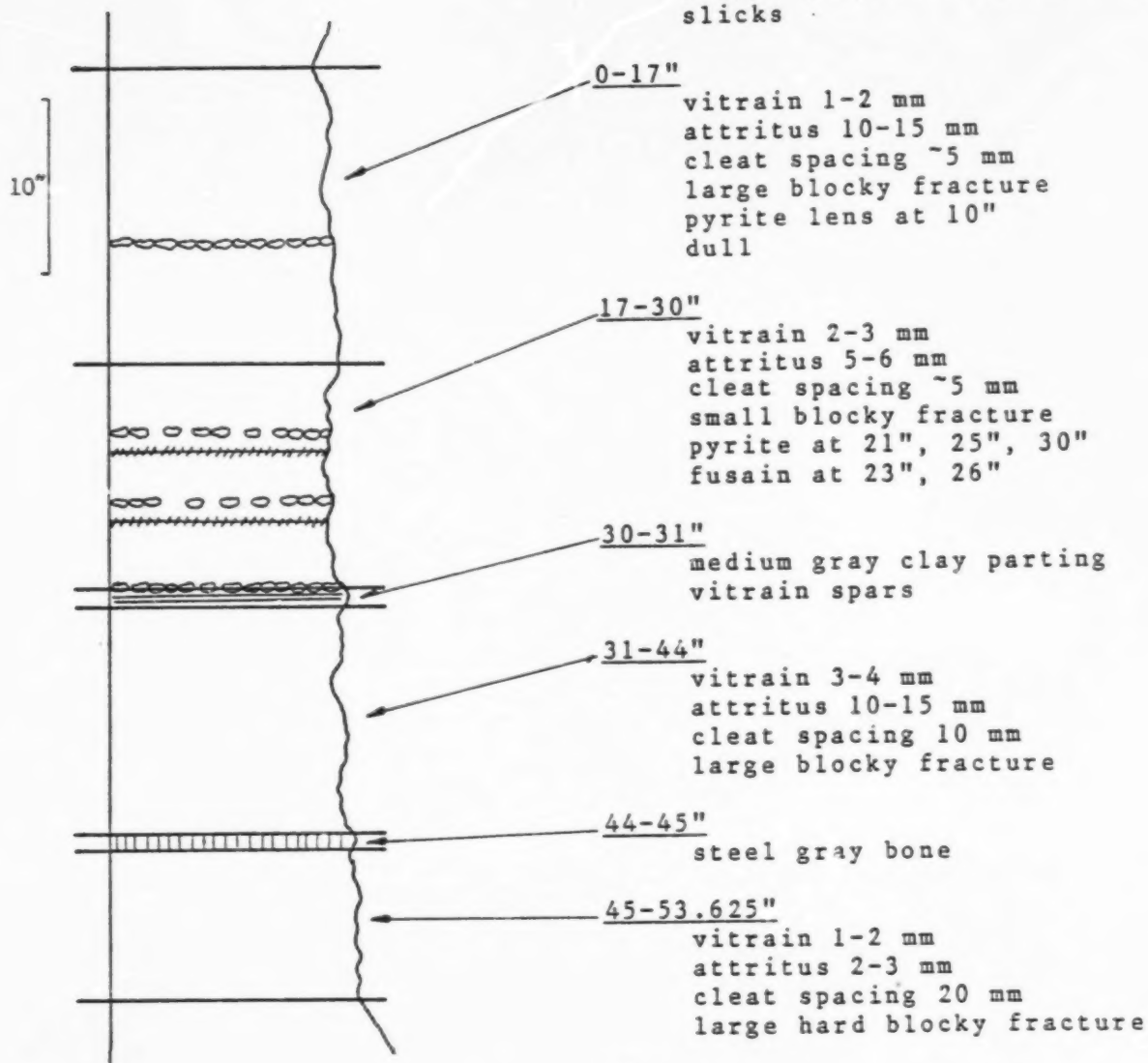


Figure 11a. Location of channel descriptions in 1 East and core #2714, 1984 sampling.

Total coal thickness: 53.625"

Roof

2.5" canneloid
medium gray with vitrain spars
slicks



Floor

medium gray claystone

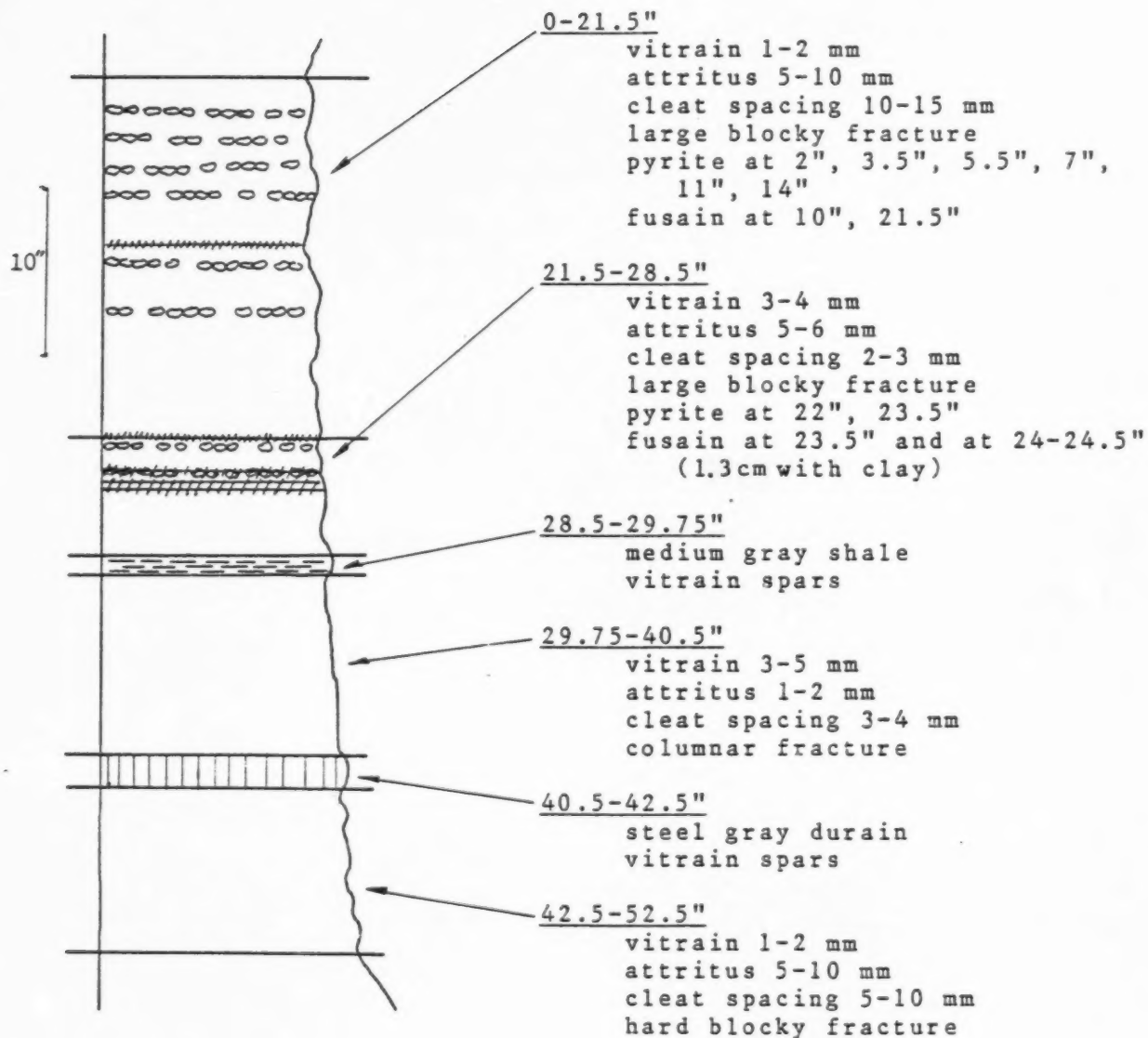
Figure 11b. In-mine description of channel #1 (1 East, 1984) collected near core #2714.

(1" of cannel roof is included in channel sample)

Total coal thickness: 52.5"

Roof

canneloid



Floor

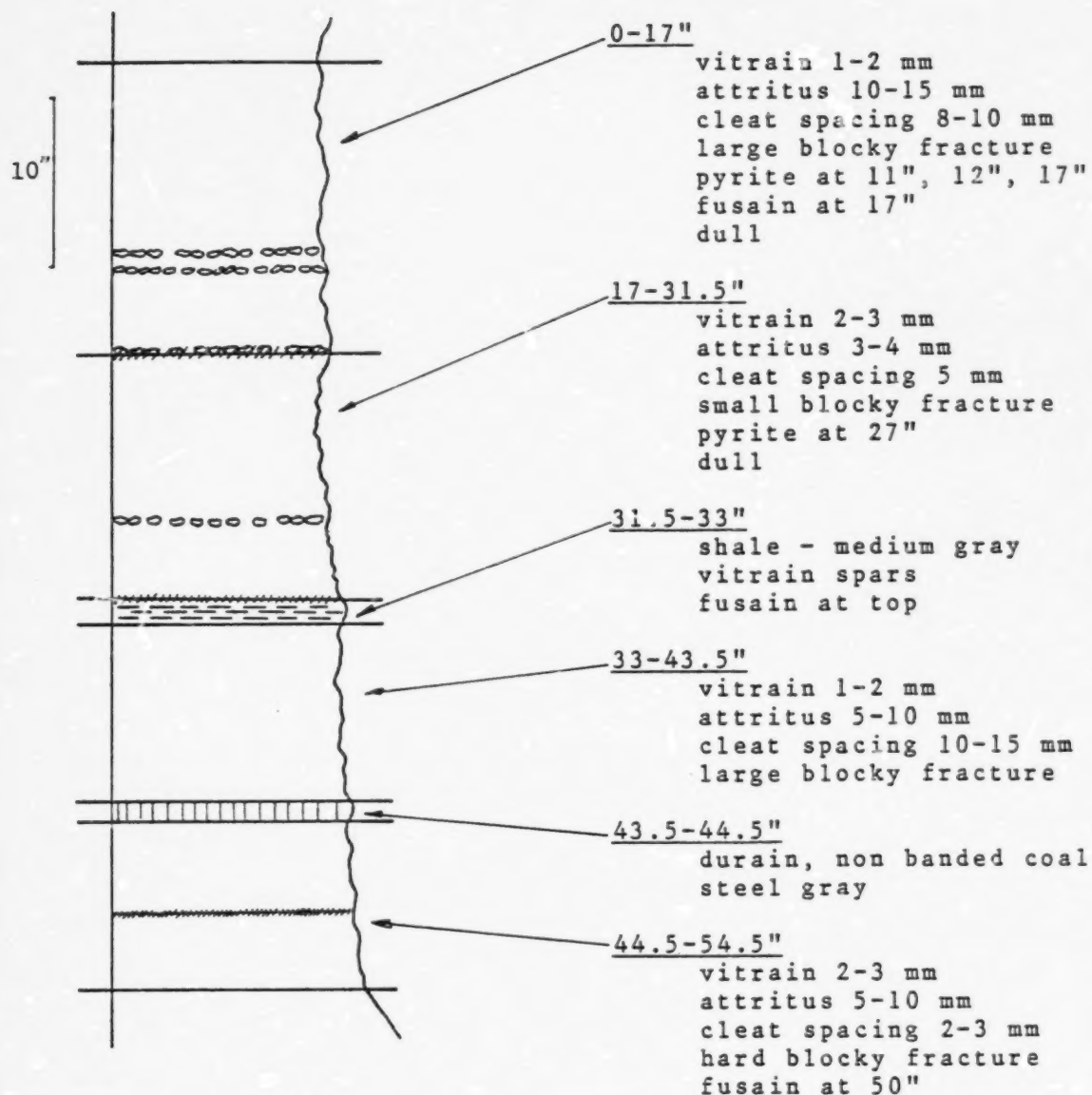
medium gray claystone

Figure 11c. In-mine description of channel #2 (1 East, 1984) collected near core #2714.

Total coal thickness: 54.5"

Roof

2" of canneloid with plant impressions
medium gray
slicks



Floor

medium gray claystone
slicks

Figure 11d. In-mine description of channel #3 (1 East, 1984) collected near core #2714.

Total coal thickness: 63.5"

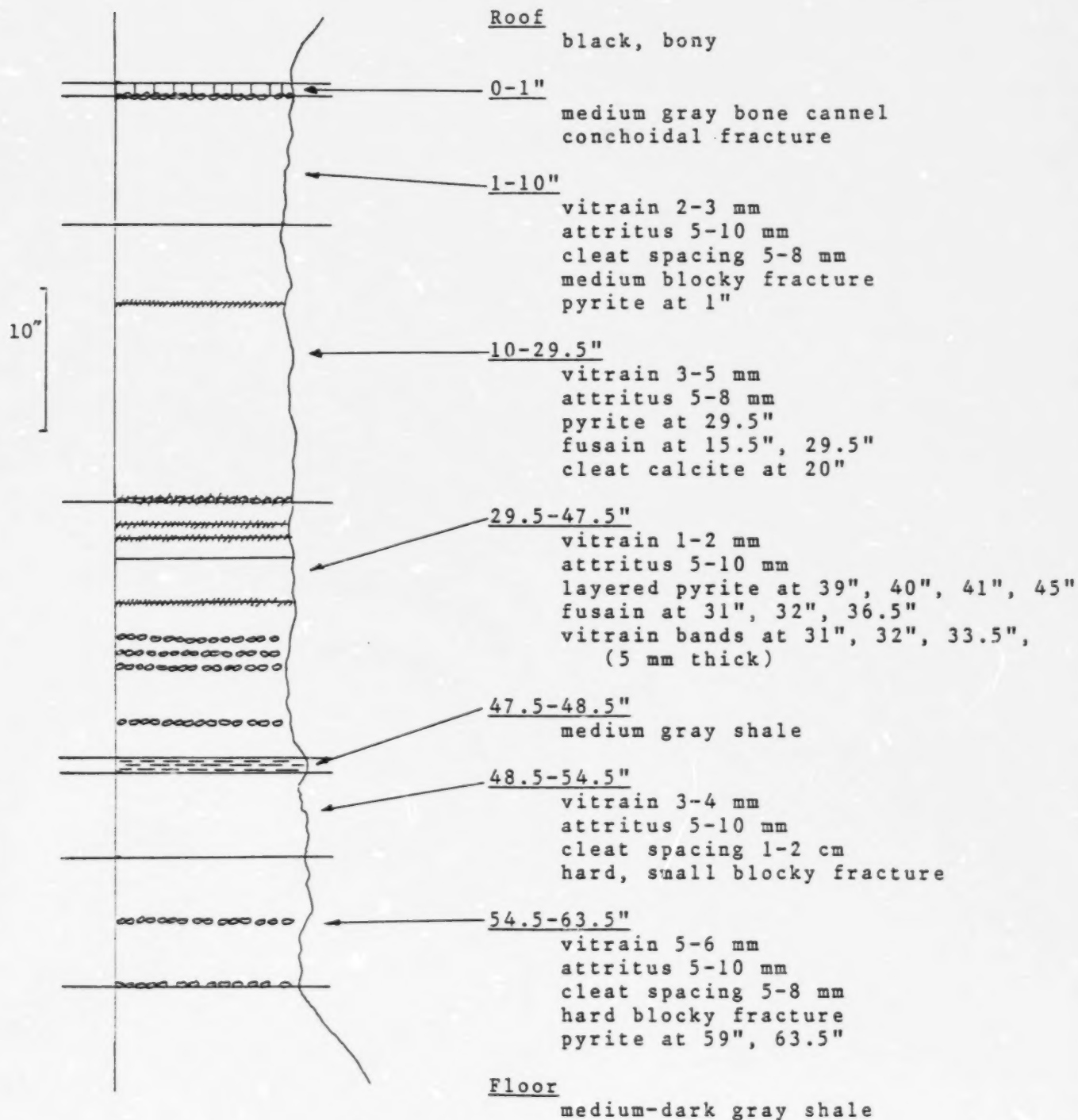


Figure 12. In-mine description of sample taken in 4 North, 1982 sampling.

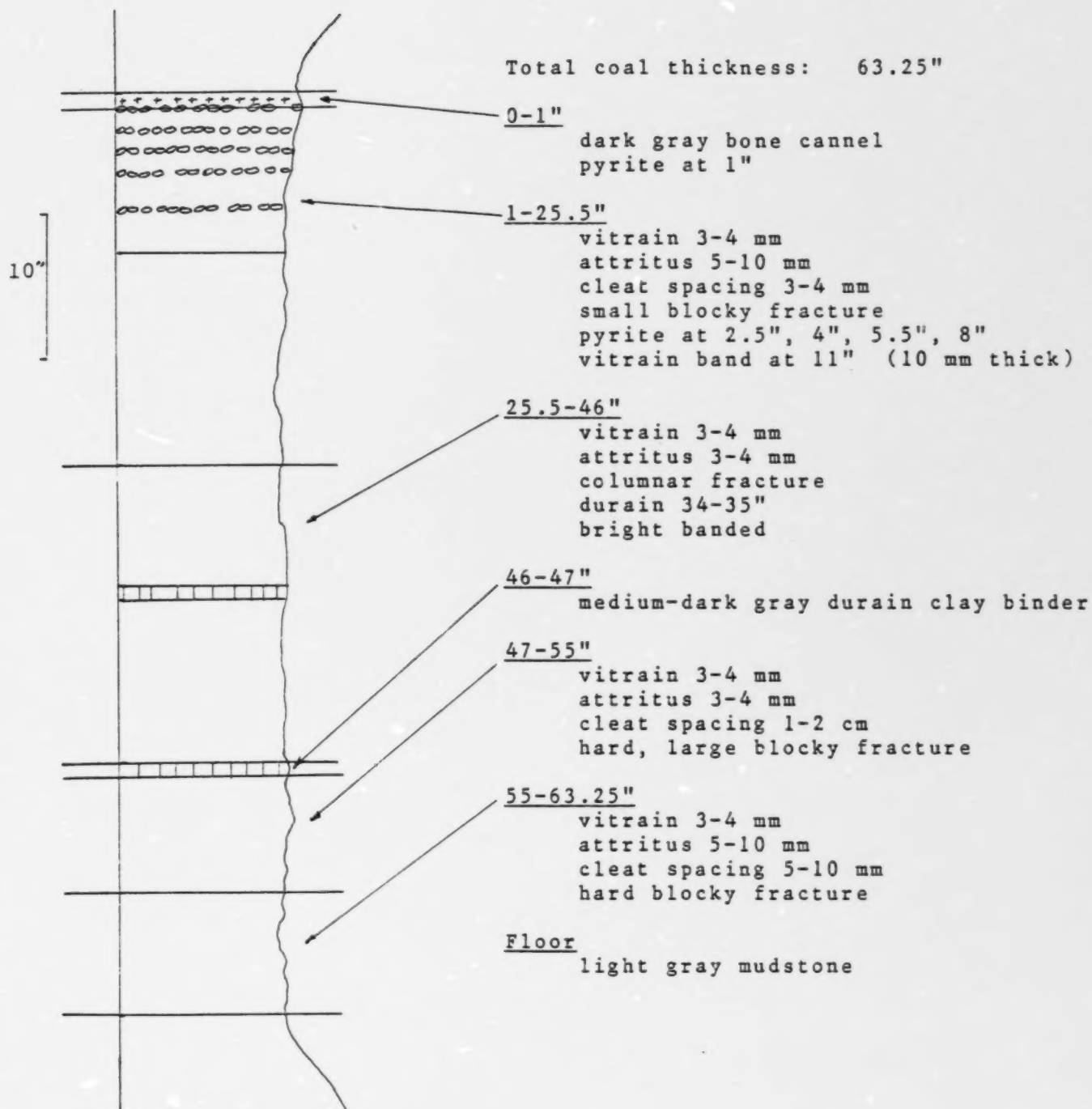
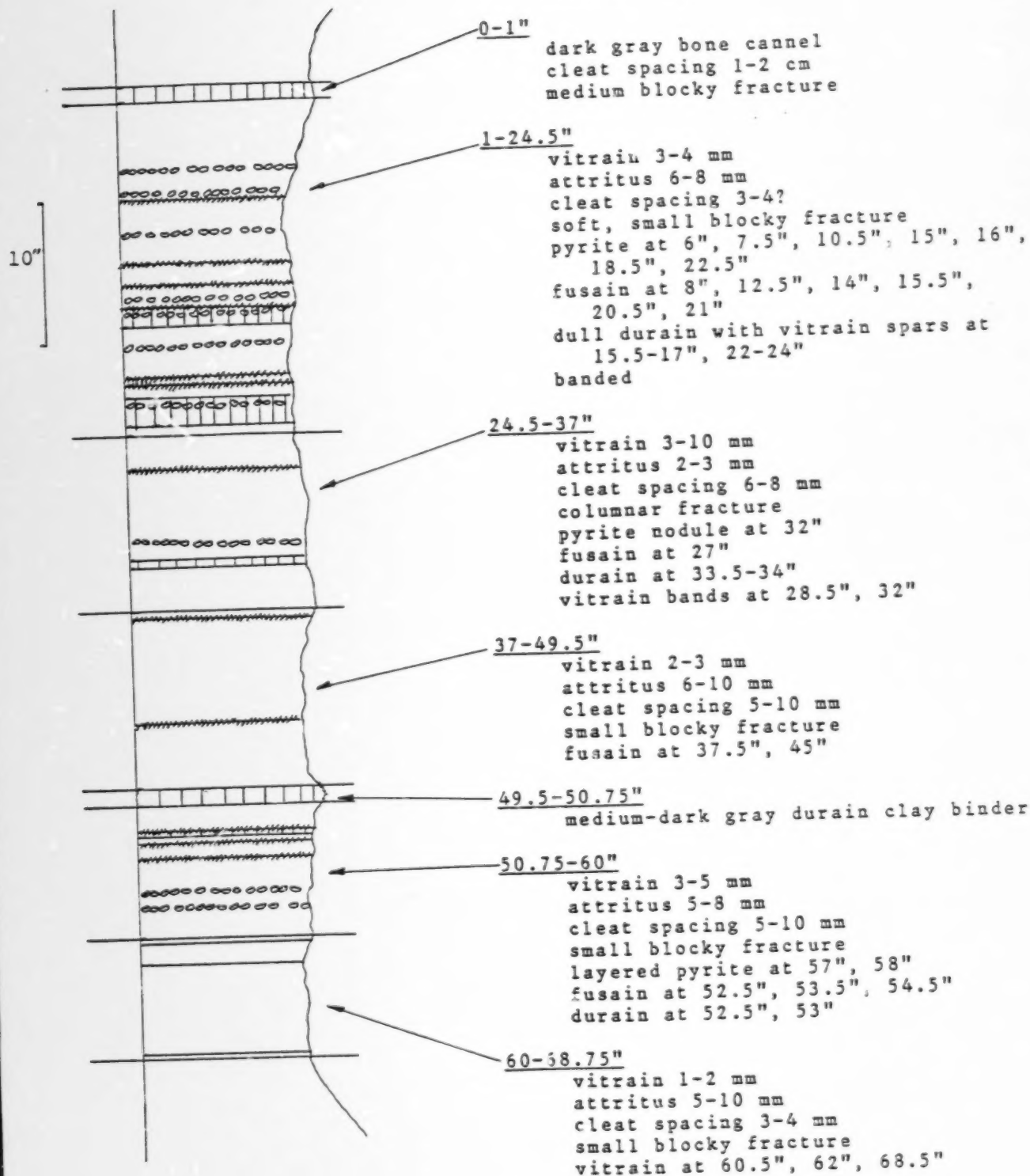


Figure 13. In-mine description of sample taken in 4 South, 1982 sampling.

Total coal thickness: 68.75"

Roof

black, bony

Floor

medium gray shale

Figure 14. In-mine description of sample taken in West Mains,
1982 sampling.

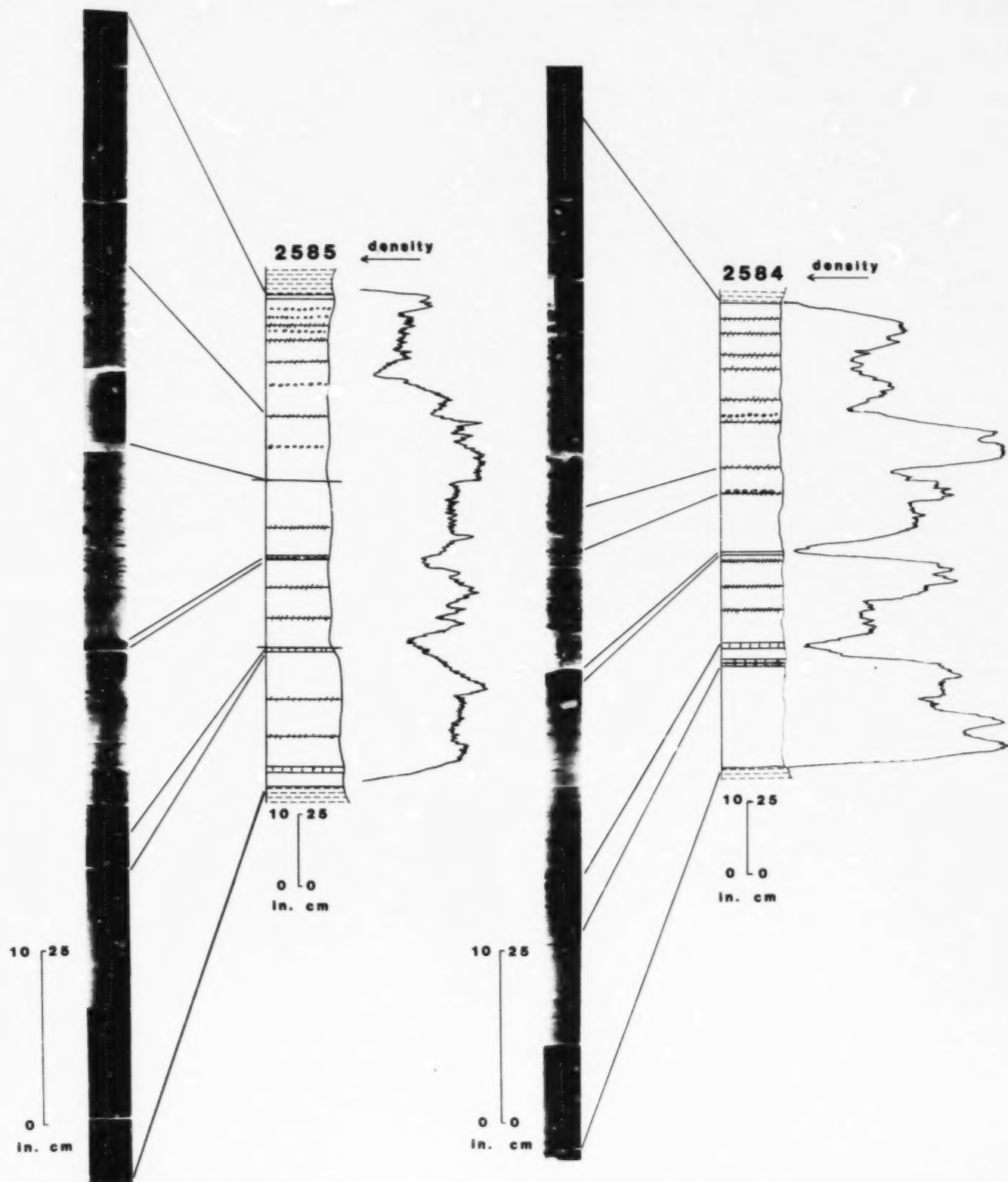


Figure 15 - Comparison of high-resolution density logs, megascopic logs, and x-ray radiographs of drill hole numbers 2584 and 2585 (locations are described in figures 4c and 5c).

PERCENT BRIGHT BANDS OF COAL FACIES

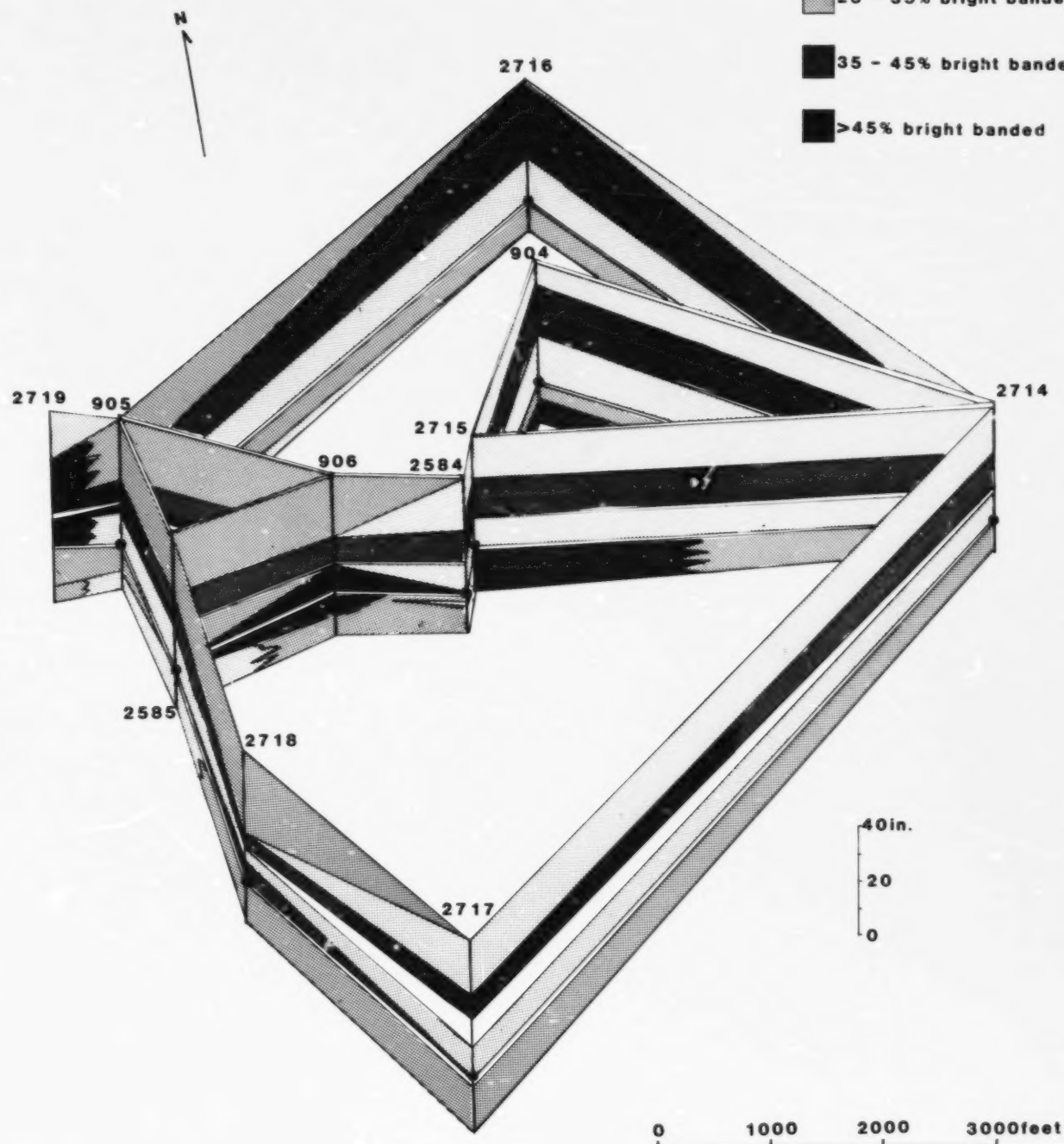


Figure 16 - Correlation of descriptions of underground mine sampling locations, Lucerne #9 Mine, west-central Pennsylvania

Table I Summary of 1982-84 descriptions at 11 locations in the Lucerne #9 Mine.

Year	Section Location	Number of Channel Samples	Number of Channel Descriptions	Core Number	Description Numbers	Figures	X-radio- graphy
1983	3 South	7	5	2584	1,3-4-5,6,7,8	4b-f	yes
1983	5 South	7	5	2585	1,3-4-5,6,7,8	5b-f	yes
1984	3 South	8	4	2715	1,2,3,4	6b-e	planned
1984	4 South	5	3	2717	1,2,3	7b-d	planned
1984	4 North	7	3	2716	1,2,3	8b-d	planned
1984	5 South	8	6	2718	1,2,3,4,5-6-7,8	9b-g	planned
1984	West Mains	6	5	2719	1,2,3,4,5-6-7	10b-f	planned
1984	1 East	8	3	2714	1,2,3	11b-d	planned
1982	4 North (904-C)		1			12	
1982	4 South (906-C)		1			13	
1982	West Mains (905-C)		<u>1</u>			14	
Lucerne #9 Total			37				